ARTD

SOLUTIA
Applied Chemistry, Creative Solutions

Solutia Inc.
J. F. Queeny Plant
201 Russell Blvd.
St. Louis, Missouri 63104
Tel 314-622-1400

November 7, 2001

Mr. James Gulliford
Regional Administrator
U.S. Environmental Protection Agency
Region VII
901 N. 5th Street
Kansas City, Kansas 66101

RE: Data Gap Work Plan Implementation
Solutia J.F. Queeny Facility
EPA ID No. MOD004954111

Dear Mr. Gulliford:

Enclosed for the EPA's and MDNR's review are revised copies of the human health risk assessments for two SWMUs that are being evaluated as part of the Data Gap RCRA Facility Investigation at Solutia's John F. Queeny facility located in St. Louis, MO. The risk assessments for the Former Coal Storage Area and the Former Bulk Chemical Storage Area are being segregated and expedited at the previous request of the Agency. The draft final documents were submitted to the Agencies on August 3 of this year. The attached revised assessments have addressed the EPA's and MDNR's draft comments that were received before and discussed during our meeting at the Queeny facility on August 22nd and in later discussions.

These assessments and all supporting information will also be found in the final Data Gap RFI Report. However, we are also submitting these reports separately in order to continue to expedite the evaluations of the areas and to address the outstanding Notice of Violation (NOV) that exists for the units.

The results of the risk evaluations for the two areas are very favorable. At the Former Coal Storage Area, no unacceptable risks exist under current or potential future conditions. As such, Solutia requests that a No Further Action determination be made for this unit.

At the Former Bulk Chemical Storage Area, no unacceptable risks exist under current conditions. Unacceptable exposure could potentially occur under a future indoor site

worker scenario. There currently are no buildings on the property. This potential can be mitigated using proper site controls. Risk management measures will be addressed as we continue forward in the RCRA Corrective Action process. Solutia is currently in full control of this property but is aware that should this property be leased or sold, that provisions to control future exposures may need to be part of any agreement. Solutia will advise the Agency of an anticipated change in ownership.

Solutia believes that the additional investigation that has been performed at these SWMUs and this Final Risk Assessment submission fully addresses the EPA's requests regarding these units and the associated NOV. We look forward to the Agency's confirmation of this.

Should you have any questions or require any additional information, please call Michael House, the Solutia Manager for this project. He can be reached at 314-674-6717.

Sincerely,

Robin K. Prokop
Plant Manager

Enclosures

Cc: Richard Nussbaum, Missouri Department of Natural Resources
Tom Herrmann, Schaeffer Manufacturing
Robert Cheever, Solutia

Bcc: Alan Faust, Solutia (w/o enclosures)
Michael House, Solutia " "
Jim Sherman, Solutia " "
Robert Billman, URS " "

EXPEDITED RISK EVALUATION FORMER BULK CHEMICAL STORAGE AREA

SOLUTIA – QUEENY FACILITY
ST. LOUIS, MISSOURI

Prepared for
Solutia Inc.
575 Maryville Centre Drive
St. Louis, MO 63141

October 22, 2001

URS
2318 Millpark Drive
Maryland Heights, Missouri 63043
(314) 429-0100
(314) 429-0462
23-20000058.00

1.0 Introduction

An expedited risk evaluation was performed for the Former Bulk Chemical Storage Area, which was formerly part of the Solutia - J. F. Queeny facility in St. Louis, Missouri. Previous investigations have indicated the presence of a number of constituents in soil and groundwater at the site. Both current and hypothetical future uses of the facility were evaluated to estimate the potential threat to human health resulting from the presence of these constituents.

The methodologies used in performing this risk evaluation are consistent with guidelines established by the EPA in Risk Assessment Guidance for Superfund (RAGS) (EPA, 1989a). The risk evaluation was conducted in the following phases as listed below and detailed in following sections:

- Site Description
- Identification of Constituents of Potential Concern
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization

In addition, a complete record of analytical data used in preparing this report, and a more detailed presentation of the modeling assumptions used, will be included in the RFI Data Gap Report for the Queeny Facility.

1.1 Site Description

The Solutia – J. F. Queeny Plant is a heavily industrialized, 56-acre area that is located 500 to 800 feet west of the Mississippi River. A Missouri-Pacific railroad yard is located between the site and the Mississippi River. Adjacent to the railroad yard, the Mississippi River is constrained by flood walls and has limited accessibility to the public, due to other industrial properties along the river.

Several industries are located along the northern and southern boundaries of the site. Commercial properties, parking lots and vacant land are located immediately to the west. The nearest residential neighborhood is located approximately three blocks west of the site. Based on current zoning and the industrial nature of the site, future use of the site is expected to remain industrial/commercial.

The Former Bulk Chemical Storage Area (Figure 1, photograph included as Attachment 1) is a rectangular shaped parcel of land 285 feet by 300 feet (approximately 1.94 acres). It was purchased in 1968 and included two (2) 500,000 gallon storage tanks and two (2) 300,000 gallon storage tanks used in the past for fuel storage. Raw materials, used at the J. F. Queeny Plant, were unloaded from a barge terminal, located on the west bank of the Mississippi River, and pumped into these tanks for storage. Materials stored at the terminal by Monsanto and others included:

- Petroleum products
- Alkyl benzenes
- Blends of alkyl benzenes (Purex A-220 and Canadian A-221)
- Santicizer 154 plasticizer (p-t-butylphenyl diphenyl phosphate)
- Monochlorobenzene
- ortho-Nitrochlorobenzene
- Sodium hydroxide
- Potassium hydroxide

The use of the Bulk Chemical Storage Area was discontinued in 1987, after roughly 20 years of use. This area has also been leased to others. The site is considered a Solid Waste Management Unit (SWMU) and Solutia is conducting Resource Conservation and Recovery Act (RCRA) corrective action activities at the site.

The site is currently unimproved. The ground surface is covered with both crushed and compacted stone, soil and/or sparse vegetation. No buildings are located on the SWMU. The SWMU is located outside of the main J. F. Queeny property and site security fence, but is fully enclosed by a locked eight foot high security fence. Access to the site requires authorization from Solutia. The SWMU is bordered to the north, south and west by several industries and the Missouri-Pacific railroad yard. Wharf Street and the floodwall separate the Former Bulk Chemical Storage Area from the Mississippi River.

The geology of the Former Bulk Chemical Storage Area consists of fill material overlying a fine-grained silt and clay. A sand unit separates the silts and clay from the underlying bedrock. The depth to bedrock varies from approximately 70 to 80 feet beneath ground surface at the SWMU. The fill material consists predominantly of a silt, gravel and clay mix and is present in the area to approximately 10 feet below ground surface.

Shallow groundwater is intermittently present in wells screened in the fill and silty clay. Deeper groundwater is present in the sand unit that underlies the southern portion of the site. Groundwater is typically located approximately 25 feet below ground surface at the Former Bulk Chemical Storage Area. Groundwater flow is east toward the Mississippi River.

2.0 Constituents of Potential Concern (COPCs)

Previous sampling events have indicated the presence of a number of constituents in soil at the site. Soil analytical data for the Former Bulk Chemical Storage Area were compared with EPA Region III Risk Based Concentrations (RBCs), EPA Soil Screening Levels for soil transfer to groundwater (SSLs) assuming a 20X Dilution Attenuation

Factor (DAF)[a], Missouri Department of Natural Resources (MDNR) Cleanup Levels for Missouri (CALM) industrial soil (scenario C) values and State of Missouri CALM leaching to groundwater values (MDNR September 1998). Constituents with any detected concentrations above screening criteria were identified as constituents of potential concern (COPCs) for soil at the site. Table 1 summarizes the results of the screening of the soil data.

The following is a list of constituents that were identified as constituents of potential concern in surface soils (0-2 feet below ground surface) for the Former Bulk Chemical Storage Area:

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Antimony
- Arsenic
- Beryllium
- Chromium
- Lead
- Thallium

The following is a list of constituents that were identified as constituents of potential concern in subsurface soils (0-10 feet below ground surface)[1] for the Former Bulk Chemical Storage Area:

- Chlorobenzene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Indeno-(1,2,3-cd)pyrene
- Naphthalene
- Nitrobenzene
- Antimony
- Arsenic
- Barium
- Beryllium
- Cadmium
- Chromium
- Lead
- Thallium

Previous sampling events have indicated the presence of a limited number of constituents in groundwater at the site. The groundwater monitoring wells in the Former Bulk Chemical Storage Area are screened at varying depths within the aquifer layers. These layers consist of silts and clays, sand and bedrock. The Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings (USEPA, 1997) was used to estimate the risks associated with constituent volatilization from groundwater and concentration into a building. The Johnson and Ettinger model is based on constituent volatilization from the uppermost groundwater unit, the silts and clays. Groundwater analytical data for the

[a] The 20X DAF was developed by EPA to predict allowable concentrations of constituents in groundwater at a facility boundary assuming the water would be used as a domestic drinking water source. Given that there is no use of groundwater at or near the site, nor any potential for direct contact with site groundwater, the 20X DAF is considered a conservative screening approach for selection of COPCs.

[1] Soils deeper than 10 feet bgs were included when evaluating potential migration of VOCs from subsurface soils to building interiors. No additional COPCs were identified in these deeper soils.

uppermost aquifer layer in the Former Bulk Chemical Storage Area were compared with EPA Maximum Contaminant Levels (MCLs). In the event that no MCLs were available, groundwater data were compared to EPA Region III Risk Based Concentrations (RBCs). Constituents with any detected concentrations above screening criteria were identified as COPCs for groundwater at the site. Table 2 summarizes the results of the screening process for the groundwater data.

Groundwater was evaluated as a potential source for migration of volatile constituents into a building. The following is a list of volatile constituents that exceeded the groundwater screening criteria for the Former Bulk Chemical Storage Area:

- Benzene
- Chloroform
- cis/trans-1,2,-Dichloroethene
- Vinyl Chloride
- Chlorobenzene
- 2-Chlorophenol
- Methylene chloride
- bis(2-ethylhexyl)phthalate

For purposes of evaluating potential exposure to surface and subsurface soils by different worker populations, soil data were separated into two groups. Calculations involving surface soils were based on soil analytical data taken from 0 to 2 feet beneath ground surface. For exposure to subsurface soils, analytical data used in calculations were based on the exposure pathway being evaluated. Soil depths used for each calculation involving exposure to subsurface soils are explained further in the risk characterization section.

Analytical data for soil sampling results at the Former Bulk Chemical Storage Area are summarized in Table 1. Soil sample results are from sampling events in June 2000, March 1994 and March 1991. Complete analytical results from each sample will be presented in the RFI Data Gap Report. Analytical data for sampling results for groundwater in the uppermost aquifer layer at the Former Bulk Chemical Storage Area are summarized in Table 2. All groundwater data are from June and July 2000; the most recent sampling performed. Sampling locations are shown in Figure 1.

3.0 Exposure Assessment

The purpose of the exposure assessment is to estimate the magnitude of potential constituent intake for various receptor populations. The steps required to perform an exposure assessment include the following:

- Identification of potential receptor populations (both current populations as well as hypothetical future populations)
- Evaluation of potential exposure pathways for completeness
- Evaluation of exposure assumptions
- Estimation of exposure point concentrations

The approach of this risk evaluation is to incorporate conservative exposure assumptions when estimating the magnitude of potential constituent intake, so that potential risks posed by the area of concern are not underestimated. At the same time, exposure scenarios that are considered unlikely are excluded since they do not reflect realistic exposure conditions. In this risk evaluation, exposure is defined for both central tendency exposure (CTE) and reasonable maximum exposure (RME) conditions. The RME is meant to represent the high-end exposure for an individual in a population while the CTE represents the exposure for an individual under average conditions.

3.1 Identification of Potential Receptor Populations

The receptor population is identified as the individual or group of individuals that may be potentially exposed to site related constituents. The potential receptor population may include both present and future populations. Given that this letter report focuses only on the Former Bulk Chemical Storage Area, potential off-site exposure issues are not evaluated in this report. The potential for off-site migration of COPCs and their impact on the Mississippi River will be addressed at a later time in the Baseline Risk Assessment that is being prepared as part of the Solutia-Queeny RFI Data Gap Report. Potential receptors for the Former Bulk Chemical Storage Area and their definitions are summarized below:

- **Future Construction/Utility Worker:** Employees or contractors of the facility who perform duties in which they are exposed to subsurface soils through excavation work.

- **Future Outdoor Site Worker:** Employees of the facility who work outside performing non-intrusive duties (i.e., not involved in soil excavation).

- **Future Indoor Site Workers:** Employees working in a building constructed over impacted soils and groundwater. This is a potential future use population. There are currently no buildings at the Former Bulk Chemical Storage Area.

- **Future Site Trespasser:** Potential trespassers onto the site property.

3.2 Evaluation of Potential Exposure Pathways

An exposure pathway is a mechanism by which a receptor may come into contact with a constituent. An exposure pathway consists of the following four elements as defined in RAGS (EPA, 1989a):

- A source and mechanism of constituent release
- A medium of transport for the constituent
- An exposure point at which the receptor may make contact with the constituent
- An exposure route through which constituent uptake by the receptor may occur

The evaluation of potential exposure pathways for completeness of the four elements is critical, since health risks do not exist in the absence of a complete exposure pathway. Complete pathways, which are determined to have the potential to adversely impact human health or environmental receptors, must be addressed when evaluating potential risks.

Figure 2 presents a site conceptual exposure model (SCEM) for the Former Bulk Chemical Storage Area. This figure is a visual depiction of potentially complete exposure pathways and the sources and mechanisms by which receptor populations might be exposed. As demonstrated in this figure, the original source of impacts at the Former Bulk Chemical Storage Area would have been spills or leaks of products handled at or near the facility. Once released, these constituents would have mixed/leached into surface soil and eventually into underlying subsurface soil and groundwater. Groundwater has the potential to migrate off-site to the Mississippi River (impacts to the river will be evaluated as part of the site-wide RFI). Exposure to impacted media can occur when an individual comes into contact with the media. Because groundwater is not used at the site, and is located deeper than would typically be encountered during construction activities, there is little likelihood of any direct exposure to that medium, although there could be exposure to VOCs released from groundwater into air. Exposure to site related constituents in soils could occur via direct contact, via incidental ingestion, or indirectly via inhalation as VOCs are released into air.

The following is a summary of the results of the exposure pathway evaluation for each potential receptor population at the site:

- **Future Construction/Utility Worker:** Construction and utility workers may potentially be exposed to surface and subsurface constituents in soils at the site. Volatilized constituents emanating from impacted surface and subsurface soils at the site could potentially expose workers through inhalation. Workers could also potentially be exposed to impacted soils via direct dermal contact and subsequent incidental ingestion (i.e., hand-to-mouth activity).

- **Future Outdoor Site Worker:** Future outdoor employees of the facility could be exposed to surface soil at the site via direct dermal contact and subsequent incidental ingestion. Current outdoor employees at the facility are unlikely to be exposed to significant amounts of surface soil at the site because of control measures undertaken by Solutia. The majority of the potential exposure areas are covered with either asphalt or gravel.

  Outdoor workers are considered to have minor potential exposure via inhalation of constituents volatilized from groundwater and soil through a similar exposure pathway as the indoor site worker. This pathway is considered minor for the outdoor worker because of the low flux and large dilution of the constituent vapors as they reach the surface and disperse into the outside air.

- **Future Site Trespasser:** Future trespassers onto the site property could potentially be exposed to impacted surface soil at the site via the same pathways as an outdoor site worker, although the frequency of exposure would be less. These exposures are evaluated under the assumption that current exposure controls, such as asphalt cover or gravel were removed.

- **Future Indoor Site Worker:** Constituents in the groundwater and surface and subsurface soil could potentially volatilize and migrate to the surface where they could enter and concentrate in buildings constructed above impacted areas. Future workers in these buildings could be exposed to the volatilized constituents through inhalation.

3.3 Evaluation of Exposure Assumptions

In order to calculate the chronic daily intake (CDI) for exposure to constituents and to estimate the associated potential health risks, a number of exposure parameters must first be quantified. The exposure parameter values used in this risk assessment have been selected from the Exposure Factors Handbook (EPA, 1997, 1989b), OSWER Directive 9285.6-03 (Standard Default Exposure Factors; EPA, 1991a), RAGS (EPA, 1989a), Peer Review Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (EPA, 2001b) and through the use of professional judgement.

Exposure was evaluated for both RME and CTE exposure. The RME is an estimate of the maximum exposure that can reasonably be expected to occur. The CTE represents a more typical exposure for the average individual. The exposure parameters that have been incorporated into the risk calculations for this report are listed in Table 3 and described in the following paragraphs.

3.3.1 Averaging Time

The assumed lifespan, used as the averaging time for evaluating carcinogens, as given in the OSWER Directive 9285.6-03 (EPA, 1991a), is 70 years (25,550 days) for all receptors.

The averaging time used for evaluating non-carcinogens was based on the duration and frequency of exposure. For exposure pathways with exposure durations of more than one year, the averaging time for non-carcinogens was calculated by multiplying the exposure duration times 365 days/year. For the future construction/utility worker pathway, which had an exposure duration of less than one year, the averaging time for non-carcinogens was an estimate of the total number of days that the construction activity would take to complete (including weekends and holidays). An estimate of 60 days was used for CTE and 240 days for RME.

3.3.2 Exposure Duration

Exposure duration refers to the number of years in which exposure occurs. On-site workers are assumed to have an RME duration of 25 years as given in OSWER Directive 9285.6-03 (EPA 1991a). A CTE exposure duration of 5 years was assumed, based on information supplied by the Bureau of Labor Statistics (U.S. Department of Labor, 1987) showing 5 years to be the average time an individual spends at one job.

For a trespasser, the exposure duration is assumed to be 30 years for RME and 9 years for CTE exposure based on the assumption that a trespasser could be a local resident.

Utility installation is considered the most likely future site-specific excavation activity. This type of activity generally occurs over a relatively short duration. Based on professional judgment, utility construction activity is assumed to be completed within one construction season, which is assumed to be 8 months.

3.3.3 Exposure Frequency

Exposure frequency refers to the total number of days per year spent at the site.

Current and future on-site workers are assumed to spend 250 days per year on-site for both RME and CTE exposure, based on a 5-day working week for 50 weeks per year (OSWER Directive 9285.6-03; EPA, 1991a).

Hypothetical future utility/construction workers are assumed to have an exposure frequency of 30 days and 15 days for RME and CTE exposure, respectively. This is based on professional judgement regarding the length of time subsurface construction on this 1.9 acre parcel would take to complete.

Because the site is controlled, trespassers are assumed to visit the Site on an infrequent basis. It is conservatively assumed that the trespasser will visit the area 12 days per year for RME and 6 days per year for CTE exposure.

3.3.4 Incidental Soil Ingestion Rate

The incidental soil ingestion rate refers to the amount of soil that is ingested daily via incidental contact (e.g., hand-to-mouth contact). For RME exposure, Standard Default Exposure Factors (EPA, 1991a) recommends soil ingestion rates of 50 mg/day for worker populations. The incidental ingestion rate for industrial workers of 50 mg/day is also the value recommended by EPA (1997) for all adults. This value is applied to the assessment of an on-site worker scenario. For calculations of CTE exposure, a value of 25 mg/day was used. These exposure estimations were also assumed to apply to a site trespasser.

Since soil excavation activity may involve increased exposure to soil, 200 mg/day was used as the RME soil ingestion rate for construction workers. This RME value is four

times the RME value recommended by EPA (1997) for evaluation of worker exposure, although less than the upperbound value of 330 mg/day identified in Peer Review Draft EPA Guidance[2] (EPA, 2001b). For calculations of average exposure, a value of 100 mg/day was used.

3.3.5 Body Weight

The body weight for an adult was obtained from OSWER Directive 9285.6-03 (EPA, 1991a). The assumed body weight for adults is 70 kg. This value was used for on-site workers, construction/utility workers and trespassers.

3.3.6 Skin Surface Area

Exposed skin surface area is important when evaluating uptake of constituents that are absorbed dermally. For dermal exposure to soil, an RME surface area of 3,300 cm^2 was estimated for potential adult receptor scenarios (hypothetical construction workers, utility workers, trespassers, and on-site workers) based on the adult surface areas of face, forearms, and hands (Exposure Factors Handbook; EPA, 1997). For central tendency exposure, the total exposed surface area, assumed to be limited to the head and hands, was 2,000 cm^2 (EPA, 1997).

3.3.7 Soil Adherence Factor

Dermal soil adherence is used, in conjunction with exposed skin surface area, to define the total amount of soil adhering to exposed skin surfaces. RME and CTE adherence rates for the construction/utility worker scenario were 0.2 mg/cm^2 for RME and 0.07 mg/cm^2 for CTE as currently suggested by USEPA Region VII (USEPA 2001b).

For trespassers, RME and CTE adherence rates were taken from the Exposure Factors Handbook (EPA, 1997). An adherence rate of 0.025 mg/cm^2 was used for both RME and CTE, based on the reported mean soil adherence of soil to hands, head and arms for soccer players.

3.3.8 Dermal Soil Absorption Factor

Dermal soil absorption values, used to estimate constituent absorption through the skin, were assumed to be 10 percent for semi-volatile organic compounds based on the Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (EPA, 2001b). As specified in the draft guidance, inorganic and volatile organic compounds were not evaluated for dermal exposure.

[2] Given the Peer Review Draft status of this guidance document, this value should be considered tentative.

3.3.9 Exposure Time

Exposure time refers to the number of hours per day in which the exposure occurs. A standard workday is eight hours long. The RME exposure time for the future construction/utility worker of 4 hours per day assumes that half of that time is spent actually working in the trench. A CTE exposure duration of 2 hours per day was assumed, also based on professional judgement.

3.10 Inhalation Rate

The inhalation rate was used to estimate the volume of trench air that the future construction/utility worker might breath while working in a hypothetical trench. Inhalation rates were taken from the Exposure Factors Handbook (EPA, 1997). An inhalation rate of 2.05 m^3/hour, based on the assumption that half of the time spent working in a trench would involve moderate activity levels and half-heavy activity levels, was used to evaluate the RME scenario. For the CTE scenario, a rate of 1.3 m^3/hour was used, based on the assumption that half of the time spent working in a trench would involve light activity levels and half-moderate activity levels.

3.4 Exposure Point Concentrations

3.4.1 95% UCL based on the H-statistic

Reasonable maximum exposure (RME) point concentrations were estimated as the lower of either the 95% UCL of the mean for the constituent concentration or the maximum detected concentration of the constituent. Central tendency exposure point concentrations (the average concentration of a constituent at the point of receptor contact) were estimated as the lower of either the RME concentration of the constituent or the arithmetic mean of the constituent concentration. A surrogate concentration of ½ of the detection limit was used for non-detected samples in the calculation of the arithmetic mean and 95% UCL of the mean.

The 95% UCL was calculated based on guidance from USEPA (USEPA, 1992a). Since site related environmental impacts would be expected to be distributed lognormally, all data for the site were initially treated as lognormally distributed data sets. The assumption that the data is lognormally distributed results in a conservative estimation of the 95% UCL and thus a more conservative estimate of constituent exposure point concentrations. The analytical data for each constituent was first transformed by taking the natural logarithm of each result. The mean and standard deviation of the transformed data were calculated by standard statistical methods. The equation below was then used to calculate the 95% UCL for each constituent:

$$UCL = e^{(\bar{x}+0.5s^2+sH/\sqrt{n-1})}$$

Where:

UCL = upper confidence limit
e = base of the natural log (2.718)
x = mean of the log transformed data
s = standard deviation of the log transformed data
H = H statistic (obtained from statistics table)
n = number of samples

The 95% UCL was not calculated for data sets with only one detected concentration.

All current (Year 2000) groundwater data were included in the calculation of the exposure point concentrations for the Former Bulk Chemical Storage Area. Groundwater monitoring wells throughout the Former Bulk Chemical Storage Area are screened at varying depths within the aquifer layers. Wells MW-24B, MW-25B and VW-2B are screened in the sand layer. Wells MW-24A, MW-25A, VW-1 and VW-2 are screened in the silt and clay subsurface layer. Data from all seven wells were combined in the calculation of the groundwater exposure point concentrations. All groundwater results used in the calculation of exposure point concentrations were from unfiltered groundwater samples. In the event that duplicate samples were collected, the following methodology was used to select the result used for calculation of the exposure point concentration:

- If one result was qualified as detected and the other as not detected, the detected value was used
- If both results were qualified as detected, the original sample result was selected
- If both results were qualified as not detected, the result with the lower detection limit was selected

3.4.2 95% UCL based on Non-parametric Methods

The accuracy of the H-statistic relies on the assumption that data set being analyzed is lognormally distributed. For sample data that are not log-normally distributed, the use of the H-statistic to estimate the 95% UCL results in a 95% UCL value that is unrealistically large. This can be seen in the 95% UCL, as calculated by the H-statistic, for several COPCs in which the calculated value greatly exceeds the maximum detected concentration for the constituent. Based on USEPA guidance, a non-parametric statistical method for calculating the 95% UCL may be more appropriate for these constituents (USEPA, 1997d). These non-parametric methods include several bootstrap and jackknife methods. Although these are commonly used statistical calculations, a

discussion of the procedural basis for these methods is beyond the scope of this document.

Various non-parametric statistical methods were used to calculate the 95% UCL for constituents of potential concern with five or more data points in which the 95% UCL, as calculated by the H-statistic method, exceeded the maximum detected concentration for the constituent. In the Former Bulk Chemical Storage Area, exposure point concentrations (95% UCL) for chlorobenzene in soil from 0 – 10 feet below ground surface and from 0 feet below ground surface to the groundwater table were calculated using the standard bootstrap method.

It is important to note that there may be other constituents for which the non-parametric tests may give a more realistic estimate of the 95% UCL than the use of the H-statistic. In these cases, the use of the H-statistic method is considered more conservative as it will likely result in a higher estimation of the 95% UCL than any of the non-parametric methods. The non-parametric methods were applied only in instances in which the H-statistic method appeared to grossly exaggerate the estimation of the 95% UCL (i.e., the 95% UCL was higher than the maximum detected concentration).

4.0 Toxicity Assessment

To estimate the potential non-carcinogenic hazards posed by the COPCs at the site, a hazard index (HI) approach was used. The concept of the hazard index is based on the assumption that non-carcinogenic toxicological effects of constituents occur only after a threshold dose is achieved. The reference dose (RfD) for a compound is an estimate of the threshold dose below which the most sensitive human population will not experience an observed adverse effect for that compound. The hazard index is the ratio of the intake of a constituent to it's specific reference dose. A hazard index in excess of one indicates that the threshold limit has been exceeded and a potential health hazard may exist. A hazard index of less than one indicates that adverse health effects are not expected to occur.

To estimate the potential risk from exposure to carcinogenic constituents of potential concern at the site, incremental carcinogenic risks were calculated. The incremental carcinogenic risk provides an estimate of the potential increase in cancer incidence for a receptor population. An incremental cancer risk of 1×10^{-6} corresponds to 1 chance in one million that an individual will acquire cancer due to exposure to site constituents. A risk range of 10^{-4} to 10^{-6} represents EPA's opinion on what are generally acceptable levels (National Oil and Hazardous Substances Pollution Contingency Plan, March 1990, 40 CFR 300).

The hierarchy of sources of toxicity values used in the risk assessment is listed below:

- EPA Integrated Risk Information System Database (IRIS) (EPA, 2001a)
- Health Effects Assessment Summary Table (HEAST) (EPA, 1997)

- EPA Region III Risk Based Concentration (RBC) Table (EPA, 2000b)

A summary of the Toxicity Values used in this Risk Assessment is presented in Table 4.

Lead is not evaluated in a risk evaluation using the same methods applied to other constituents. While it has both carcinogenic and non-carcinogenic properties, EPA does not furnish either slope factors (SFs) or reference doses (RfDs) for lead. Lead is a neurodevelomental toxicant, and its toxic properties are related to an individuals age. Young children are especially sensitive to lead. EPA has developed two computer models to estimate lead uptake from various environmental media (EPA, 1996). These lead models predict blood lead levels in children or in the case of the adult lead model, fetuses. Application of the Adult Lead Model (EPA 1996) to an industrial setting results in an allowable surface soil lead concentration in the range of 750-1,750 mg/kg, depending on the demographic makeup of the workforce. These numbers are designed to be protective of a developing fetus in a pregnant site worker. For this risk evaluation, lead soil concentrations will be compared to the 750-1,750 mg/kg range.

5.0 Risk Characterization

The purpose of risk characterization is to quantify and describe the potential health risks associated with site-specific impacts.
In this portion of the Risk Assessment, potential health risks are estimated for each COPC and exposure pathway. These risk estimates are calculated using the exposure parameters developed in Section 3.0 and the toxicity values reported in Section 4.0.

5.1 Equations and Models Used to Calculate Risks and Hazards

5.1.1 General Risk Equations

Potential cancer risks and non-cancer hazard quotients have been calculated using the following equations:

Equation 1 (soil ingestion - cancer):

$$CR = \frac{C(S) * IRs * EF * ED * CF * SF}{BW * ATc}$$

Equation 2 (direct dermal contact with soil - cancer)

$$CR = \frac{C(S) * SA * AD * AB * EF * ED * CF * SF}{BW * ATc}$$

Equation 3 (soil ingestion – non-cancer)

$$HQ = \frac{C(S) * IRs * EF * ED * CF}{BW * ATnc * RfD}$$

Equation 4 (direct dermal contact with soil - non-cancer)

$$HQ = \frac{C(S) * SA * AD * AB * EF * ED * CF}{BW * ATnc * RfD}$$

Where:

CR = Cancer risk (unitless)
C(S) = Contaminant concentration in soil (mg/kg)
IRs = Soil ingestion rate (mg/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Conversion factor (kg/mg)
SF = Cancer slope factor $(mg/kg\text{-}day)^{-1}$
RfD = Non-cancer reference dose (mg/kg-day)
BW = Body weight (kg)
ATc = Averaging time for carcinogenic effects (days)
ATnc = Averaging time for non-carcinogenic effects (days)
SA = Exposed dermal surface area (cm^2/day)
AD = Soil adherence rate (mg/cm^2)
AB = Dermal absorption rate (unitless)

5.1.2 Soil and Groundwater Contaminant Volatilization into a Building

The hazard/risks associated with soil and groundwater constituent volatilization into a building were estimated using the Johnson-Ettinger model for contaminant volatilization into a building (EPA, 1997). This is a spreadsheet application obtained from the EPA. Tier 2 soil and Tier 2 groundwater models were run to allow for some input of site-specific parameters. Soil and groundwater calculations were run individually.

Parameters used in the calculations can be seen in Table 5. Standard default values in the spreadsheet were used unless otherwise noted. The building was modeled to have a slab concrete floor extending 15 cm into the ground. The depth of soil impact used in the model was based on the detected depth range of the contamination and varied by constituent. In all cases, the finite source model was used. The soil was classified as silty clay. The average soil temperature was set to 14°C, based on the climatic region of the site. As noted in Table 3, the exposure duration and averaging time for non-carcinogens were changed from default values.

Soil exposure point concentrations were based on the depth at which the constituent was detected. The maximum detected concentration of a constituent was used as the RME

exposure point concentration. The CTE concentration was estimated by the use of the lower of the RME concentration or the arithmetic mean of the concentrations of the constituent. The mean concentration was determined only over the depths at which the constituent was detected. Calculations were performed only for volatile COPCs. These are defined as COPCs with a MW of less than 200 and a Henry's Law constant of 1×10^{-5} atm-m^3/mole or greater (EPA, 1991b).

5.1.3 Soil Contaminant Volatilization into a Trench

A multi-step approach was used to estimate the risk to the future construction/utility worker from the inhalation of volatilized soil contaminants while working in a trench. The Exposure Model for Soil-Organic Fate and Transport (EMSOFT, USEPA, 1997c) was first used to calculate the average flux of volatilized constituents from impacted soils into trench air. A box model (USEPA, 1999) was then used to convert the constituent flux into an average trench air concentration. The predicted trench air constituent concentration was then used to calculate potential risks and hazards. Calculations were performed only for volatile COPCs. These are defined as COPCs with a MW of less than 200 and a Henry's Law constant of 1×10^{-5} atm-m3/mole or greater (USEPA, 1991b).

Parameters used in the EMSOFT modeling and Trench Box Model are presented in Table 6. Constituent properties for the EMSOFT model (e.g., diffusivity in air, Henry's law constant, etc.) were taken from the values in the Johnson and Ettinger Model spreadsheet. The non-carcinogenic averaging time for the exposure scenario was used as the time period for averaging constituent flux in the EMSOFT program. The constituent concentration was assumed to be evenly distributed throughout the entire area that the trench was cut through. The spatial locations of the impacted soil were not accounted for in this model.

The box model to convert constituent flux into a trench air concentration was based on a trench 30-m long and 3-m high. A trench width of 10-m at the opening with a 3-m floor was used in the calculations, based on Solutia excavation guidelines (see Appendix 4) for a trench of 3-m depth. The box model was modified to fit the trapezoidal shape of the trench. Constituent volatilization was only assumed to emanate from the 3-m wide floor of the trench. No volatilization was assumed from the angled sides of the trench. An air exchange rate of 0.15 exchanges per second (based on a 10-mph wind speed) was used to account for air replenishment in the trench. A mixing factor of 0.5 was incorporated to account for incomplete mixing of air in the trench.

Exposure point concentrations for the soil contaminant volatilization into a trench pathway were taken from the subsurface soil (0-10 feet below ground surface) data. Reasonable maximum exposure point concentrations were estimated as the lower of either the 95% UCL of the mean for the constituent concentration or the maximum detected concentration of the constituent. Central tendency exposure point concentrations were estimated as the lower of either the RME concentration or the arithmetic mean of the constituent concentration. A surrogate concentration of ½ of the

detection limit was used for non-detected samples in the calculation of the arithmetic mean and 95% UCL of the mean.

5.1.2 Exposure to Lead in Soils

Lead concentrations were compared with the allowable lead concentrations in soil as estimated by the EPA Adult Lead Model (EPA 1996).

5.2 Results

Total non-carcinogenic hazard indices and carcinogenic risks for each receptor population and exposure route are presented in Table 7 and summarized below.

5.2.1 Future Construction/Utility Worker

The future construction/utility worker scenario was developed to evaluate potential exposures to subsurface soils. The total CTE non-carcinogenic hazard index was 0.1 for the site. RME hazard indices ranged from 0.000002 to 0.05. The total CTE cancer risk was 1×10^{-7}. RME cancer risks ranged from 2×10^{-7} to 8×10^{-7}.

5.2.2 Current/Future Outdoor Site Worker

The current/future outdoor site worker scenario was developed to evaluate routine daily exposure to site surface soil by worker populations. Non-carcinogenic hazard indices were 0.05 (CTE) and 0.1 (RME) for the site. The total CTE cancer risk was 2×10^{-6}. RME cancer risks ranged from 3×10^{-6} to 2×10^{-5}.

5.2.3 Current/Future Site Trespasser

The current/future site trespasser scenario was developed to evaluate occasional exposure to site surface soil by non-worker populations. Non-carcinogenic hazard indices were 0.0009 (CTE) and 0.004 (RME) for the site. The total CTE cancer risk was 6×10^{-8}. RME cancer risks ranged from 6×10^{-8} to 1×10^{-6}.

5.2.4 Future Indoor Site Worker

The future indoor site worker scenario was developed to evaluate potential air emissions into a future building from soils and groundwater underlying the site. The total CTE non-carcinogenic hazard index was 1 for the site. RME hazard indices ranged from 0.01 to 3. Total Cancer risks were 8×10^{-7} (CTE) and 4×10^{-6} (RME). The primary constituent contributing to the elevated non-carcinogenic hazard index for the future indoor site worker is chlorobenzene in soil via the inhalation pathway.

5.2.5 Exposure to Lead in Soils

Lead concentrations in soil were screened to evaluate the potential risk to a developing fetus in a pregnant site worker. Lead concentrations in surface soils (0-2 feet) were 830 mg/kg (CTE) and 1100 mg/kg (RME) for the Former Bulk Chemical Storage Area. Lead concentrations in subsurface soils (0-10 feet bgs) were 840 mg/kg (CTE) and 2700 mg/kg (RME) for the Former Bulk Chemical Storage Area. The RME (but not the CTE) lead concentration in subsurface soil slightly exceeds the surface soil target range of 750-1,750 mg/kg calculated by the adult lead model. However, given that these soils are not accessible, and that lead concentrations would undoubtedly be diluted via mixing with surface soils if excavation were to bring the subsurface soils to the surface, it is unlikely that these subsurface soils would pose any risk.

6.0 Conclusions

The risk evaluation performed for the Former Bulk Chemical Storage Area indicates that risks and hazards are acceptable for current uses of the site. However, hazards and/or risks could be unacceptable for some hypothetical future use scenarios that assume unrestricted industrial site use.

Chlorobenzene in soil was identified as a potential non-carcinogenic hazard to the future indoor site worker via the inhalation pathway.

As the site currently exists, lead does not pose a risk to any receptor populations, nor is it likely to in the future, based on the discussion presented in Section 5.2.5. It is important to note that EPA recommends exposure controls as a primary means of preventing lead-related risks (EPA, 1994), and that such controls (e.g., fencing and ground cover to prevent exposure) are currently in place at the site.

7.0 References

Hawley, J.K. 1985. Assessment of Health Risk From Exposure To Contaminated Soil. Risk Anal. 5:289-302.

U.S. Environmental Protection Agency (EPA). 1989a. Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation, Part A. Interim Final. EPA/540/1-89/002.

U.S. Environmental Protection Agency (EPA). 1989b. Exposure Factors Handbook. May.

U.S. Environmental Protection Agency (EPA). 1990. National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR 300.

U.S. Environmental Protection Agency (EPA). 1991a. Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.

U.S. Environmental Protection Agency (EPA). 1991b. Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). December.

U.S. Environmental Protection Agency (EPA). 1992a. Supplemental Guidance to RAGS: Calculating the Concentration Term. OSWER Publication 9285.7-081.

U.S. Environmental Protection Agency (EPA). 1992b. Dermal Exposure Assessment: Principles and Application. Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1994. Guidance on Residential Lead-based paint, lead-contaminated dust and lead-contaminated soil. Guidance from Lynn R. Goldman, Assistant Administrator, Office of Prevention, Pesticides and Toxic Substances. July.

U.S. Environmental Protection Agency (EPA). 1997. Exposure Factors Handbook. August.

U.S. Environmental Protection Agency (EPA). 1997a. Health Effects Assessment Summary Tables, FY-1997 Update.

U.S. Environmental Protection Agency (EPA). 1997b. User' Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings. Office of Emergency and Remedial Response, Toxics Integration Branch. September.

U.S. Environmental Protection Agency (EPA). 1997c. EMSOFT User's Guide. National Center for Environmental Assessment. February.

U.S. Environmental Protection Agency (USEPA). 1997d. The Lognormal Distribution in Environmental Applications. December.

U.S. Environmental Protection Agency (EPA). 1998. Supplemental Guidance to RAGS: Region 4 Bulletins. Human Health Risk Assessment. Interim. January 16.

U.S. Environmental Protection Agency (EPA). 1999. Derivation of a Volatilization Factor to Estimate Upper Bound Exposure Point Concentration for Workers in Trenches Flooded with Ground Water Off-gassing Volatile Organic Chemicals. Memo from Helen Dawson. July.

U.S. Environmental Protection Agency (EPA). 2000a. Region IX Preliminary Remediation Goals.

U.S. Environmental Protection Agency (EPA). 2000b. Region III Risk Based Concentration (RBC) Tables.

U.S. Environmental Protection Agency (EPA). 2001a. IRIS (Integrated Risk Information System) Search.

U.S. Environmental Protection Agency (EPA). 2001b. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Peer Review Draft. OSWER 9355.4-24. March.

U.S. Department of Labor (DOL). 1992. Employee Tenure and Occupational Mobility in Early 1990's. USDL 92-386.

Table 1
Comparison of Soil Data to Screening Criteria
Bulk Chemical Area
Solutia - Queeny

	Maximum	Minimum	Arithmetic Mean	Frequency	CALM value for Industrial Soil (Scenario C)	Region III RBC for Industrial Soil	USEPA SSL - 20 DAF	CALM Leaching to Groundwater
SURFACE SOIL (0-2')								
Organics	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Acenaphthene	1.6	0.089	0.84	2/2	14000	120000	570	1190
Anthracene	3.5	0.18	1.8	2/2	69000	610000	12000	16700
Benzo(a)anthracene	**6.1**	0.49	3.3	2/2	4.2	7.8	2	4.7
Benzo(a)pyrene	**4**	0.39	2.2	2/2	0.63	0.78	8	130
Benzo(b)fluoranthene	**4.6**	0.36	2.5	2/2	3.7	7.8	5	15
Benzo(g,h,i)perylene	1.5	0.4	1.0	2/2				
Benzo(k)fluoranthene	2.3	0.3	1.3	2/2	32	78	49	150
Chrysene	4.3	0.54	2.4	2/2	143	780	160	470
Dibenzo(a,h)anthracene	0.12	0.12	NA	1/2	0.57	0.78	2	4.5
Dibenzofuran	0.043	0.043	NA	1/2		8200		
Fluoranthene	8.3	1.1	4.7	2/2	1900	82000	4300	4480
Fluorene	1.6	0.073	0.84	2/2	9300	82000	560	940
Indeno-(1,2,3-cd)pyrene	1.5	0.25	0.88	2/2	11	7.8	14	41
Phenanthrene	7.3	0.88	4.1	2/2				
Pyrene	8.6	1.4	5.0	2/2	6900	61000	4200	4480
SURFACE SOIL (0-2')								
Inorganics	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Antimony	**11**	7.3	9.2	2/2	12	820	5	5.3
Arsenic	**42**	34	38	2/2	14	3.8	29	
Barium	1000	540	770	2/2	9040	140000	1600	1650
Beryllium	**1.2**	0.91	1.1	2/2	0.2	4100	63	130
Cadmium	6.7	4.7	5.7	2/2	300	1000	8	11
Chromium	**270**	45	158	2/2	2700	2790610	38	38
Cobalt	12	11	11.5	2/2		120000		
Copper	450	210	330	2/2	4700	82000		
Cyanide,Total	2	2	NA	1/1	20400	41000	40	
Lead	**1100**	830	960	2/2	660			
Mercury	0.75	0.75	NA	1/1	250		2	3.23
Nickel	39	37	38	2/2	17500	41000	130	170
Selenium	1.9	1.9	NA	1/2	970	10000	5	4.37
Silver	0.65	0.65	NA	1/2	1160	10000	34	255
Thallium	**1.2**	1.2	NA	1/2	61	140	0.7	29.1
Tin	800	120	460	2/2		1200000		
Vanadium	38	35	37	2/2	200	14000	6000	
Zinc	1500	1300	1400	2/2	130000	610000	12000	73600
SOIL (0-10')								
Organics	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
4-Methyl-2-pentanone (MIBK)	0.38	0.38	NA	1/24		160000		
Acetone	0.54	0.029	58	8/24	8660	200000	16	14
Carbon disulfide	0.012	0.0084	5.8	2/24	21	200000	32	52
Chlorobenzene	**1500**	0.015	160	8/24	109	41000	1	2.2
Methylene chloride	0.016	0.0069	5.8	4/24	145	760	0.02	0.021
Tetrachloroethene	0.01	0.0064	5.8	3/24	160	110	0.06	0.42
Toluene	0.014	0.013	5.8	2/24	890	410000	12	5.13
1,2,4-Trichlorobenzene	0.9	0.9	NA	1/24	910	20000	5	76
2-Methylnaphthalene	75	0.87	5.7	2/24		41000		
Acenaphthene	74	0.089	7.1	5/24	14000	120000	570	1190
Anthracene	110	0.18	8.6	13/24	69000	610000	12000	16700
Benzo(a)anthracene	**150**	0.49	13.6	13/24	4.2	7.8	2	4.7
Benzo(a)pyrene	**88**	0.39	9.3	14/24	0.63	0.78	8	130
Benzo(b)fluoranthene	**100**	0.36	11	14/24	3.7	7.8	5	15
Benzo(g,h,i)perylene	32	0.4	5.0	13/24				
Benzo(k)fluoranthene	**47**	0.3	5.9	12/24	32	78	49	150
Chrysene	110	0.44	11	14/24	143	780	160	470
Dibenzo(a,h)anthracene	0.42	0.12	3.0	2/24	0.57	0.78	2	4.5
Dibenzofuran	74	0.043	6.9	3/24		8200		
Fluoranthene	230	1.1	21	16/24	1900	82000	4300	4480
Fluorene	63	0.073	7.1	7/24	9300	82000	560	940
Indeno-(1,2,3-cd)pyrene	**35**	0.25	5.1	13/24	11	7.8	14	41
Naphthalene	**250**	0.95	15	4/24	3100	41000	84	5.3
Nitrobenzene	**0.62**	0.62	NA	1/24	60	1000	0.1	0.144
Phenanthrene	240	0.62	21	16/24				
Pyrene	230	0.5	20	15/24	6900	61000	4200	4480
SOIL (0-10')								
Inorganics	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Antimony	**45**	6.4	7.0	7/24	12	820	5	5.3
Arsenic	**42**	4	12	24/24	14	3.8	29	
Barium	**3400**	73	720	24/24	9040	140000	1600	1650
Beryllium	**3.1**	0.59	1.1	16/24	0.2	4100	63	130

NOTE: Highlighting represents exceedence of a screening criterion.

Table 1
Comparison of Soil Data to Screening Criteria
Bulk Chemical Area
Solutia - Queeny

	Maximum	Minimum	Arithmetic Mean	Frequency	CALM value for Industrial Soil (Scenario C)	Region III RBC for Industrial Soil	USEPA SSL - 20 DAF	CALM Leaching to Groundwater
Cadmium	11	0.75	3.7	22/24	300	1000	8	11
Chromium	270	6.8	33	24/24	2700	2790610	38	38
Cobalt	20	1.4	8.1	24/24		120000		
Copper	2400	19	280	24/24	4700	82000		
Cyanide, Total	2	2	NA	1/4	20400	41000	40	
Lead	6000	14	860	24/24	660			
Mercury	1.5	0.37	0.75	4/4	250		2	3.23
Nickel	92	7.6	30	24/24	17500	41000	130	170
Selenium	1.9	1.9	NA	1/24	970	10000	5	4.37
Silver	2.9	0.65	1.2	2/24	1160	10000	34	255
Thallium	6.6	1.2	0.93	2/24	61	140	0.7	29.1
Tin	1800	7.4	150	17/24		1200000		
Vanadium	59	6	29	24/24	200	14000	6000	
Zinc	2000	63	560	24/24	130000	610000	12000	73600
ALL SOIL (0'-water table) Organics	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
4-Methyl-2-pentanone (MIBK)	0.38	0.38	NA	1/26		160000		
Acetone	0.54	0.029	70	8/26	8660	200000	16	14
Carbon disulfide	0.012	0.0084	6.2	2/26	21	200000	32	52
Chlorobenzene	1500	0.015	174	10/26	109	41000	1	2.2
Ethylmethacrylate	57	57	NA	1/26		180000		
Iodomethane	49	49	NA	1/26				
Methylene chloride	0.016	0.0069	6.2	4/26	145	760	0.02	0.021
Tetrachloroethene	0.01	0.0064	6.2	2/26	160	110	0.06	0.42
Toluene	0.014	0.013	6.2	2/26	890	410000	12	5.13
Xylene	0.15	0.15	NA	1/26	1510	4100000	29	55
1,2,4-Trichlorobenzene	0.9	0.9	NA	1/26	910	20000	5	76
2-Methylnaphthalene	75	0.12	6.8	4/26		41000		
Acenaphthene	74	0.089	6.9	5/26	14000	120000	570	1190
Anthracene	110	0.18	8.2	13/26	69000	610000	12000	16700
Benzo(a)anthracene	150	0.49	13	13/26	4.2	7.8	2	4.7
Benzo(a)pyrene	88	0.038	8.9	15/26	0.63	0.78	8	130
Benzo(b)fluoranthene	100	0.36	10	14/26	3.7	7.8	5	15
Benzo(g,h,i)perylene	32	0.034	4.9	14/26				
Benzo(k)fluoranthene	47	0.3	5.8	12/26	32	78	49	150
Bis(2-ethylhexyl)phthalate	0.079	0.079	NA	1/26	200	410	3600	70
Chrysene	110	0.44	10	14/26	143	780	160	470
Dibenzo(a,h)anthracene	0.42	0.12	3.0	2/26	0.57	0.78	2	4.5
Dibenzofuran	74	0.043	6.7	3/26		8200		
Fluoranthene	230	1.1	20	17/26	1900	82000	4300	4480
Fluorene	63	0.073	6.9	7/26	9300	82000	560	940
Indeno-(1,2,3-cd)pyrene	35	0.25	5.0	13/26	11	7.8	14	41
Naphthalene	250	0.03	15	6/26	3100	41000	84	5.3
Nitrobenzene	0.62	0.62	NA	1/26	60	1000	0.1	0.144
Phenanthrene	240	0.022	20	17/26				
Pyrene	230	0.5	19	15/26	6900	61000	4200	4480
ALL SOIL (0'-water table) Inorganics	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Antimony	45	6.4	6.6	7/26	12	820	5	5.3
Arsenic	42	2.8	12	26/26	14	3.8	29	
Barium	3400	62	690	26/26	9040	140000	1600	1650
Beryllium	3.1	0.18	1.1	18/26	0.2	4100	63	130
Cadmium	11	0.75	3.7	23/26	300	1000	8	11
Chromium	270	5	31	26/26	2700	2790610	38	38
Cobalt	20	1.4	8.0	26/26		120000		
Copper	2400	2.9	260	26/26	4700	82000		
Cyanide, Total	2	2	NA	1/6	20400	41000	40	
Lead	6000	8.1	840	26/26	660			
Mercury	1.5	0.37	0.66	5/6	250		2	3.23
Nickel	92	7.4	29	26/26	17500	41000	130	170
Selenium	1.9	1.9	NA	1/26	970	10000	5	4.37
Silver	2.9	0.65	1.5	2/26	1160	10000	34	255
Thallium	6.6	1.2	0.91	2/26	61	140	0.7	29.1
Tin	1800	7.4	140	18/26		1200000		
Total Organic Carbon	3100	3100	NA	1/1				
Vanadium	59	6	28	26/26	200	14000	6000	
Zinc	2000	16	590	26/26	130000	610000	12000	73600

NOTE: Highlighting represents exceedence of a screening criterion.

Ta 2
Comparison of Groundwater Data to Screening Criteria and Selection of COPCs
Volatile Organic Compounds in the Uppermost Aquifer Layer
Former Bulk Chemical Storage Area, Solutia - Queeny

ORGANICS (mg/L)	Maximum	Minimum	Arithmetic Mean	Frequency	MCL (when available) or Region 3 RBC (mg/L)
Benzene	15	0.035	6.1	4/4	0.005
Chlorobenzene	4.8	0.021	2.2	4/4	0.1
Chloromethane	0.0068	0.0068	NA	1/4	**0.0021**
cis/trans-1,2-Dichloroethene	0.046	0.046	NA	1/4	0.07
Ethylbenzene	0.16	0.0064	0.036	2/4	0.7
Toluene	0.016	0.00085	0.0057	4/4	1
Trichloroethene	0.0025	0.0007	0.0066	2/4	0.005
Xylene	0.37	0.014	0.086	3/4	10

NOTE: Region 3 RBCs are **BOLD**
Highlighting represents exceedence of a screening criterion. These chemicals were retained as COPCs.

Table 3
Exposure Parameters
Former Bulk Chemical Storage Area
Solutia-Queeny

	Future Construction/Utility Worker:		Current/Future Outdoor Site Worker:		Current/Future Site Trespasser:		Future Indoor Site Worker:	
	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Exposure Frequency (days/year)	15	30	250	250	6	12	250	250
Exposure Duration (years)	1	1	5	25	9	30	5	25
Incidental Soil Ingestion Rate (mg/day)	100	200	25	50	25	50	-	-
Body Weight (kg)	70	70	70	70	70	70	70	70
Averaging Time for Non-Carcinogens (days)	60	240	1,825	9,125	3,285	10,950	1,825	9,125
Averaging Time for Carcinogens (days)	25,550	25,550	25,550	25,550	25,550	25,550	25,550	25,550
Area of Exposed Skin (cm^2)	2,000	3,300	2,000	3,300	2,000	3,300	-	-
Exposure Time (hours/day)	2	4	-	-	-	-	-	-
Inhalation Rate (m^3/hour)	1.0	1.60	-	-	-	-	-	-
Dermal Soil Adherence Factor (mg/cm^2)	0.12	0.12	0.03	0.03	0.025	0.025	-	-
Dermal Absorption Factor (unitless)	chemical specific[1]	chemical specific[1]	chemical specific[1]	chemical specific[1]	chemical specific[1]	chemical specific[1]	-	-

[1]10% for semi-volatile organic compounds

Table 4
Toxicity Values for Constituents of Potential Concern
Former Bulk Chemical Storage Area
Solutia-Queeny

Chemical	Slope Factor: Oral (mg/kg-day)$^{-1}$	Slope Factor: Inhalation (mg/kg-day)$^{-1}$	Chronic Reference Dose: Oral (mg/kg-day)	Chronic Reference Dose: Inhalation (mg/kg-day)	Subchronic Oral Reference Dose (mg/kg-day)	Reference Concentration (mg/m^3)	Unit Risk Factor (μg/m^3)$^{-1}$
Benzene	NA	NA	NA	NA	NA	NTV	8.30E-06
Benzo(a)anthracene	7.30E-01	NA	NTV	NA	NTV	NA	NA
Benzo(a)pyrene	7.30E+00	NA	NTV	NA	NTV	NA	NA
Benzo(b)fluoranthene	7.30E-01	NA	NTV	NA	NTV	NA	NA
Benzo(k)fluoranthene	7.30E-02	NA	NTV	NA	NTV	NA	NA
Chlorobenzene[5]	NTV	NTV	2.00E-02	1.70E-02	NTV	2.00E-02	NTV
Chloroform	NA	NA	NA	NA	NA	NTV	2.30E-05
Chloromethane	NA	NA	NA	NA	NA	9.00E-02	NTV
2-Chlorophenol	NA	NA	NA	NA	NA	1.80E-02	NTV
cis/trans-1,2-Dichloroethene[6]	NTV	NTV	9.00E-03	NTV	NTV	3.50E-02	NTV
Dibenzo(a,h)anthracene	7.30E+00	NA	NTV	NA	NTV	NA	NA
Indeno(1,2,3-cd)pyrene	7.30E-01	NA	NTV	NA	NTV	NA	NA
Methylene chloride	7.50E-03	1.65E-03	6.00E-02	8.60E-01	NTV	3.00E+00	4.70E-07
Naphthalene[5]	NTV	NTV	2.00E-02	9.00E-04	NTV	1.40E-01	NTV
Nitrobenzene[5]	NTV	NTV	5.00E-04	6.00E-04	5.00E-03	2.00E-03	NTV
Tetrachloroethene	5.20E-02	2.00E-03	1.00E-02	1.40E-01	1.00E-01	NTV	5.80E-07
Vinyl chloride	7.50E-01	1.50E-02	3.00E-03	2.80E-02	NTV	NTV	8.40E-05
Xylene	NA	NTV	NA	NTV	NA	NTV	7.00E+00
Antimony[1]	NTV	NA	4.00E-04	NA	NTV	NA	NA
Arsenic[2]	1.50E+00	NA	3.00E-04	NA	3.00E-04	NA	NA
Barium	NTV	NA	7.00E-02	NA	7.00E-02	NA	NA
Beryllium	NTV	NA	2.00E-03	NA	5.00E-03	NA	NA
Cadmium	NTV	NA	5.00E-04	NA	NTV	NA	NA
Chromium[3]	NTV	NA	3.00E-03	NA	2.00E-02	NA	NA
Lead[7]	NTV	NA	NTV	NA	NTV	NA	NA
Thallium[4]	NTV	NA	8.00E-05	NA	8.00E-04	NA	NA

NTV indicates that no toxicity value was found for that chemical of concern
NA indicates that the exposure pathway is not applicable to this risk evaluation

[1]Oral reference dose is for metallic antimony
[2]Oral reference dose is for inorganic arsenic
[3]Oral reference dose is for chromium VI salt
[4]Oral reference dose is for thallium chloride
[5]Inhalation Refernce Dose is from USEPA Region III
[6]Reference concentration is for cis-1,2-Dichloroethene
[7]EPA does not supply toxicity values for lead. Lead is evaluated using a biokinetic model.

Table 5
Parameters Used for Johnson and Ettinger Air Modeling
Former Bulk Chemical Storage Area
Solutia-Queeny

Parameter	Units	Scenario: Soil Volatilization into a Building	Scenario: Groundwater Volatilization into a Building
Average Soil Temperature	°C	14	14
Depth Below Grade to Bottom of Enclosed Space Floor	cm	15	15
Depth Below Grade to Water Table	cm	-	750
Depth Below Grade to Top of Contamination	cm	*	-
Depth Below Grade to Bottom of Contamination	cm	*	-
Thickness of Soil Stratum A	cm	*	750
Soil Stratum Directly Above Water Table	-	-	A
SCS Soil Type Directly Above Water Table	-	-	Silty Clay (SIC)
Soil Stratum A SCS Soil Type	-	Silty Clay (SIC)	Silty Clay (SIC)
Stratum A Soil Dry Bulk Density	g/cm^3	1.5	1.5
Stratum A Soil Total Porosity	unitless	0.43	0.43
Stratum A Soil Water-Filled Porosity	cm^3/cm^3	0.15	0.2
Stratum A Soil Organic Carbon Fraction	unitless	0.006	-
Enclosed Space Floor Thickness	cm	15	15
Soil-Building Pressure Differential	$g/cm\text{-}s^2$	40	40
Enclosed Space Floor Length	cm	961	961
Enclosed Space Floor Width	cm	961	961
Enclosed Space Height	cm	488	488
Floor-Wall Seam Crack Width	cm	0.1	0.1
Indoor Air Exchange Rate	1/h	1	1

Shading of a value indicates use of a site-specific parameter

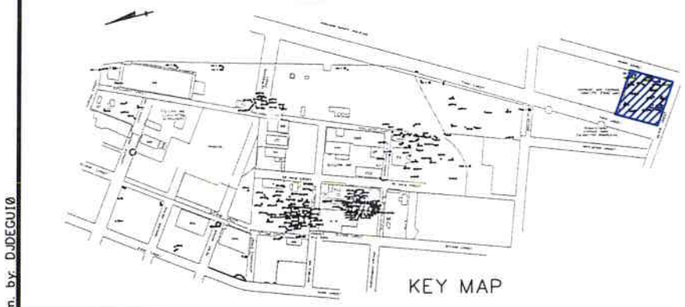
*Value was determined based on depth range of detected concentrations

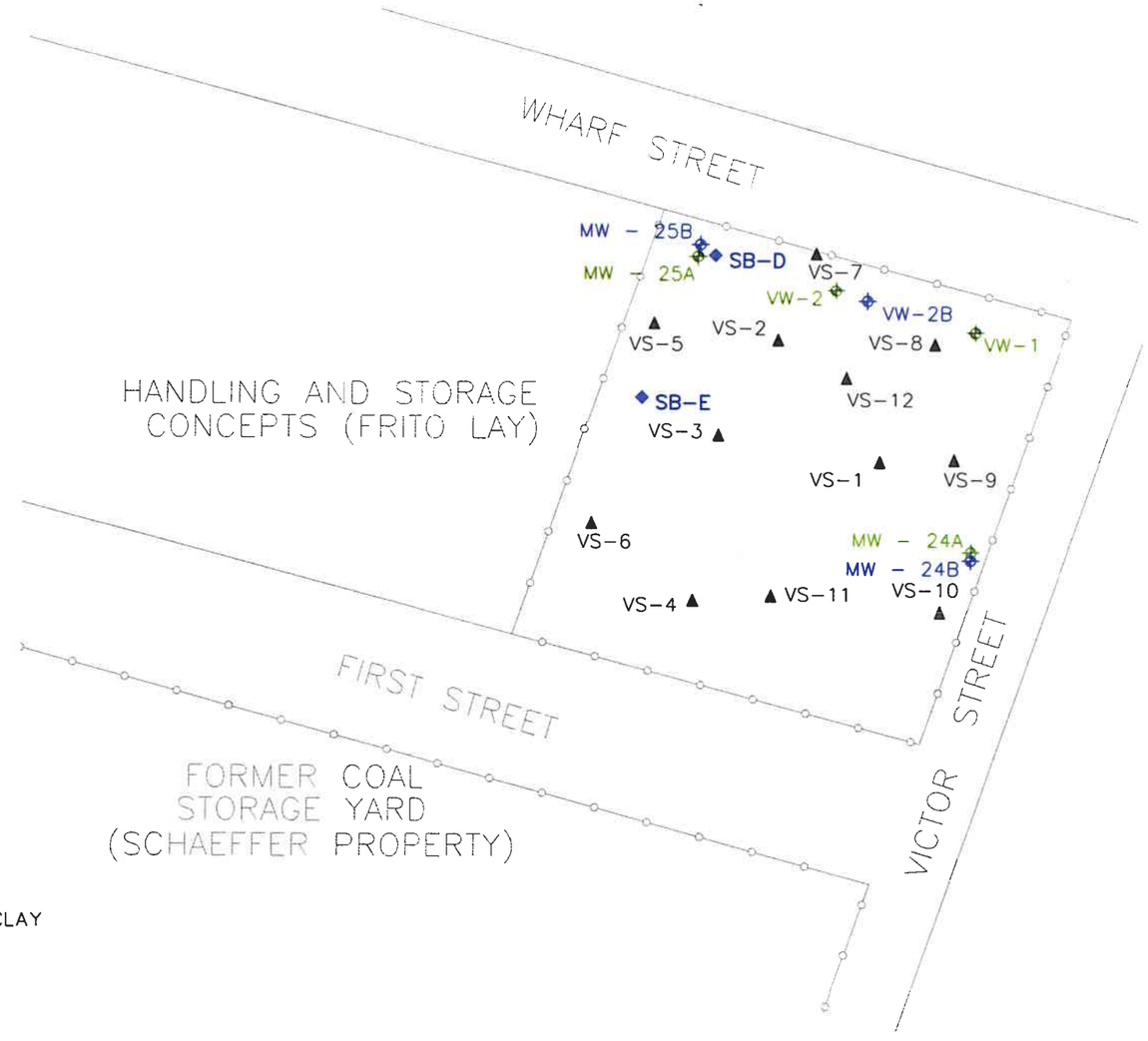
Table 6
Parameters Used for EMSOFT Air Model for Soil Constituent Volatilization into a Trench
Former Bulk Chemical Storage Area
Solutia-Queeny

Constituent Parameters:	
Organic carbon partition coefficient (cm^3/g)	chemical specific
Henry's Law constant (Dimensionless)	chemical specific
Diffusion coefficient in Air (cm^2/day)	chemical specific
Diffusion Coefficient in Water (cm^2/day)	chemical specific
Number of Layers of contamination	1
Half life (days)	999,999
Soil parameters:	
fraction of organic carbon (unitless)	0.006
Porosity (unitless)	0.43
Water Porosity (unitless)	0.15
Bulk Density (g/cm^3)	1.5
Porewater Flux (cm/day)	0
Boundary Layer Thickness (cm)	1
Cover Thickness (cm)	1
Layer Thickness (cm)	305

Table 7
Summary of Potential Cancer Risks and Non-cancer Hazard Indices
Former Bulk Chemical Storage Area
Solutia-Queeny Site

	CTE		RME	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
		Future Construction/Utility Worker		
Ingestion	9.10E-08	0.03	8.00E-07	0.04
Dermal	3.02E-08	0.0000003	2.39E-07	0.000002
Inhalation	-	0.03	-	0.05
Total	1.E-07	0.1		
		Future Outdoor Site Worker		
Ingestion	1.35E-06	0.05	1.75E-05	0.1
Dermal	1.99E-07	-	2.99E-06	-
Total	2.E-06	0.05		
		Future Site Trespasser		
Ingestion	5.83E-08	0.0009	1.01E-06	0.004
Dermal	3.06E-09	-	6.15E-08	-
Total	6.E-08	0.0009		
		Future Indoor Site Worker		
Inhalation of Soil COPCs	-	1	-	3
Inhalation of Groundwater COPCs	8.20E-07	0.01	4.10E-06	0.01
Total	8.E-07	1		





LEGEND:

- ▲ VS–1 SOIL BORING LOCATION
- ◆ SB–D RFI DATA GAP CONFIRMATORY SAMPLE
- ⊕ MW–24A WELL SCREENED IN THE FILL & SILTY CLAY
- ⊕ MW–2B WELL SCREENED IN THE SAND
- FENCE

NOTE:
SOIL ANALYTICAL SAMPLES OBTAINED FROM SOIL BORINGS AND/OR WELL LOCATION.

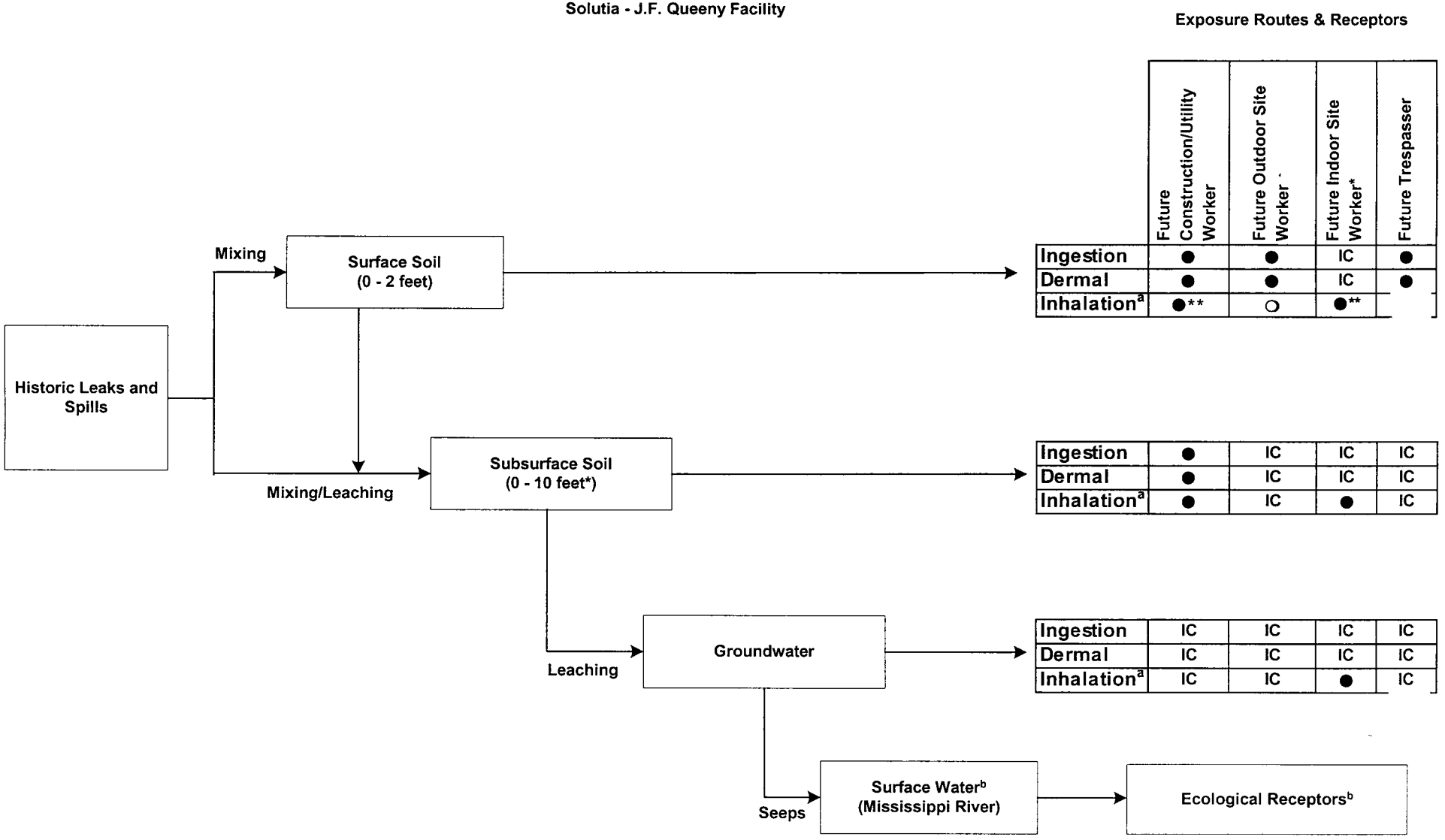
Ø 100
SCALE FEET

REFERENCE:
RCRA FACILITY INVESTIGATION DATA GAP WORK PLAN JOHN F. QUEENY PLANT BY O'BRIEN & GERE ENGINEERS, INC., SEPTEMBER 1999

SOLUTIA INC. QUEENY PLANT ST. LOUIS, MISSOURI	PROJECT NO. 23.20000058.00
URS	
DRN. BY: CHS 11/02/00 DSGN. BY: TJA CHKD. BY:	FORMER BULK CHEMICAL STORAGE AREA — FIG. NO. 1

File: K:\ENVIRON\23-20000058.00 (SOLUTIA QUEENY)\CADD\RISK ASSESSMENT\050 (SOLUTIA)FORMER BULK CHEMICAL STORAGE AREA.DWG Last edited: APR. 17, 01 @ 08:47 a.m. by: DJDECU10

Fig··· 2
Site Conceptu osure Model
Former Bulk Che ls Storage Area
Solutia - J.F. Queeny Facility



* For evaluation of indoor air, the surface soils, subsurface soils, and soils deeper than 10 feet were combined

** Evaluated as part of subsurface soils

IC Incomplete Pathway

● Complete and potentially significant

○ Complete but minor/insignificant

a Inhalation pathways refer to inhalation of volatilized compounds in a trench (construction and utility workers) or building (indoor site workers).

b There are no ecological receptors on-site. The Mississippi River is the only potential exposure point for ecological receptors. Groundwater impact to the river will be evaluated as part of the site-wide

October 22, 2001

Attachment 1

Former Bulk Chemical Storage Area
Solutia – Queeny

FORMER BULK CHEMICAL STORAGE AREA

No one is leasing this property at this time and the property is under full Solutia control. The ground covering in this area is asphalt, crushed and compacted stone, and sparse volunteer vegetation. The SWMU is located outside of the Queeny Plant main property and site security fence, but is enclosed by a locked security fence.

The photograph below depicts the former Bulk Chemical Storage Area, looking east. Note the Corps of Engineers flood wall in the background.

EXPEDITED RISK EVALUATION
FORMER COAL STORAGE YARD

SOLUTIA – QUEENY FACILITY
ST. LOUIS, MISSOURI

Prepared for
Solutia Inc.
575 Maryville Centre Drive
St. Louis, MO 63141

October 22, 2001

URS
2318 Millpark Drive
Maryland Heights, Missouri 63043
(314) 429-0100
(314) 429-0462
23-20000058.00

1.0 Introduction

An expedited risk evaluation was performed for the Former Coal Storage Yard, which was formerly part of the Solutia - J. F. Queeny facility in St. Louis, Missouri. Previous investigations have indicated the presence of a limited number of volatile organic compounds (VOCs) in soil and groundwater at the site. Both current and hypothetical future uses of the facility were evaluated to estimate the potential threat to human health resulting from the presence of these constituents.

The methodologies used in performing this risk evaluation are consistent with guidelines established by the USEPA the Risk Assessment Guidance for Superfund (USEPA 1989a). The risk evaluation was conducted in the following phases as listed below and detailed in following sections:

- Site Description
- Identification of Constituents of Potential Concern
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization

1.1 Site Description

The Solutia – J. F. Queeny Plant is a heavily industrialized, 56-acre area that is located 500 – 800 feet west of the Mississippi River. A Missouri-Pacific railroad yard is located between the site and the Mississippi River. Adjacent to the railroad yard, the Mississippi River is constrained by flood walls and has limited accessibility to the public due to other industrial properties along the river.

The Former Coal Storage Yard (Figure 1, photograph included as Attachment 1) is unimproved property purchased in 1982 from Hagar Hinge. The property was used, under Monsanto (now Solutia) Company's ownership, solely for the temporary storage of coal, in anticipation of a coal miners strike. The coal was used for boiler fuel for the J. F. Queeny Plant. The use of this area was a one-time occurrence and the property was later sold to Schaeffer Manufacturing in 1994. The site is considered a Solid Waste Management Unit (SWMU) and Solutia is conducting RCRA corrective action activities at the site.

The site is currently unimproved. The ground surface is covered with both crushed and compacted stone and coal fines. The property is currently used to temporarily store tractor trailer parts, no buildings are located on the SWMU. The SWMU is located outside of the main J. F. Queeny property and site security fence, but it is fenced along the east boundary and partially fenced to the north, south and west. The SWMU is bordered to the north, south and west by several industries and the Missouri-Pacific railroad yard. The vacant Former Bulk Chemical Storage Area, the Handling and Storage Concepts property, Slay property and the floodwall separate the Former Coal Storage Yard from the Mississippi River.

Several industries are located along the northern and southern boundaries of the site. Commercial properties, parking lots and vacant land are located immediately to the west. The nearest residential neighborhood is located approximately three blocks west of the site. Based on current zoning and the industrial nature of the site, future use of the site is expected to remain industrial/commercial. Foreseeable future use of the site includes construction of an office and/or storage facility at the western side of the property.

The geology of the Former Coal Storage Yard varies from north to south. Subsurface conditions in the northern portion consist of fill material overlying a fine-grained silty clay that rests directly on bedrock. The bedrock surface slopes to the south such that the southern portion of the site is underlain by fill, silt, clay, sand and bedrock. The depth to bedrock varies from approximately 22 feet at the north to approximately 80 feet at the south. Figure 2 depicts the site stratigraphy. The fill material consists predominantly of a silt, gravel and clay mix and is present in the area to approximately 10 feet below ground surface.

Shallow groundwater is intermittently present in wells screened in the fill and silty clay. Deeper groundwater is present in the sand unit that underlies the southern portion of the site. Groundwater is typically located approximately 25 feet below ground surface at the Former Coal Storage Yard. Groundwater flow is generally east toward the Mississippi River.

2.0 Constituents of Potential Concern (COPCs)

Previous sampling events have indicated the presence of a limited number of constituents in soil at the site. Soil analytical data for the Former Coal Storage Yard were evaluated using USEPA Region III Risk Based Concentrations (RBCs), USEPA Soil Screening Levels for soil transfer to groundwater (SSLs) assuming a 20X Dilution Attenuation Factor (DAF)[a], Missouri Department of Natural Resources (MDNR) Cleanup Levels for Missouri (CALM) industrial soil (scenario C) values and State of Missouri CALM leaching to groundwater values (MDNR September 1998). Constituents with any detected concentrations above screening criteria were identified as constituents of potential concern (COPCs) for soil at the site and received a detailed evaluation in this report. Table 1 summarizes the results of the screening of the soil data. Tetrachloroethene was the only constituent found to be of potential concern in surface and subsurface soils at the former Coal Storage Yard.

Previous sampling events have indicated the presence of a limited number of constituents in groundwater at the site. The groundwater monitoring wells in the former Coal Storage Yard are screened at varying depths within the aquifer layers. These layers consist of silts and clays, sand and bedrock. The Johnson and Ettinger Model for Subsurface Vapor

[a] The 20X DAF was developed by EPA to predict allowable concentrations of constituents in groundwater at a facility boundary, assuming the water would be used as a domestic drinking water source. Given that there is no use of groundwater at or near the site, nor any potential for direct contact with site groundwater, the 20X DAF is considered a conservative screening approach for selection of COPCs.

Intrusion into Buildings (USEPA, 1997) was used to estimate the risks associated with constituent volatilization from groundwater and concentration into a building. The Johnson and Ettinger model is based on constituent volatilization from the uppermost aquifer unit. Groundwater analytical data for the uppermost aquifer layer in the former Coal Storage Yard were screened using USEPA Maximum Contaminant Levels (MCLs). In the event that no MCLs were available, groundwater data were screened using USEPA Region III Risk Based Concentrations (RBCs). Constituents in the uppermost aquifer layer with any detected concentrations above screening criteria were identified as COPCs for groundwater at the site and received a detailed evaluation in this report. Table 2 summarizes the results of the screening process for the groundwater data.

The following is a list of constituents that were identified as constituents of potential concern in groundwater for the former Coal Storage Yard:

- Benzene
- Chloroform
- Chloromethane
- cis/trans-1,2-Dichloroethene
- Tetrachloroethene
- Trichloroethene

For purposes of evaluating potential exposure to surface and subsurface soils by different worker populations, soil data were separated into two groups. Calculations involving surface soils were based on soil analytical data taken from 0 to 2 feet beneath ground surface. For evaluating exposure to residual constituents in subsurface soils, analytical data used in calculations were based on the exposure pathway being evaluated. Soil depths used for each calculation involving exposure to residual constituents in subsurface soils are explained further in the risk characterization section.

Analytical data for soil sampling results at the Former Coal Storage Yard are summarized in Table 1. Soil sample results are from sampling events in June 2000 and March 1994. Complete analytical results from each sample will be presented in the RFI Data Gap Report. Analytical data for groundwater sampling results at the Former Coal Storage Yard are summarized in Table 2. All groundwater data are from June and July 2000; the most recent sampling performed. Sampling locations are shown in Figure 1.

3.0 Exposure Assessment

The purpose of the exposure assessment is to estimate the magnitude of potential constituent intake for various receptor populations. The steps required to perform an exposure assessment include the following:

- Identification of potential receptor populations (both current populations as well as hypothetical future populations)
- Evaluation of potential exposure pathways for completeness
- Evaluation of exposure assumptions

- Estimation of exposure point concentrations

The approach of this risk evaluation is to incorporate conservative exposure assumptions when estimating the magnitude of potential constituent intake, so that potential risks posed by the area of concern are not underestimated. At the same time, exposure scenarios that are considered unlikely are excluded since they do not reflect realistic exposure conditions. In this risk evaluation, exposure is defined for both average (central tendency exposure; CTE) and reasonable maximum exposure (RME) conditions. The RME represents the high-end exposure for an individual in a population while the CTE represents the exposure for an individual under average conditions.

3.1 Identification of Potential Receptor Populations

The receptor population is identified as the individual or group of individuals that may be potentially exposed to site-related constituents. The potential receptor population may include both present and future populations. Given that this letter report focuses only on the former Coal Storage Yard, potential off-site exposure issues related to regional groundwater quality are not evaluated in this report. The potential for off-site migration of constituents in groundwater and their impact on the Mississippi River will be addressed in the Baseline Risk Assessment that is being prepared as part of the Solutia-Queeny RFI report. Potential receptors for the Former Coal Storage Yard and their definitions are summarized below:

- **Future Indoor Site Workers:** Employees working in a building constructed over impacted soil and groundwater. This is a potential future use population. There are currently no buildings at the former Coal Storage Yard.

- **Future Outdoor Site Worker:** Employees of the facility who work outside performing non-intrusive duties (i.e., not involved in soil excavation). Current outdoor employees at the facility are unlikely to be exposed to significant amounts of surface soil at the site because of control measures undertaken by Solutia. The majority of the potential exposure areas are covered with either asphalt or gravel.

- **Future Construction/Utility Worker:** Employees or contractors of the facility who perform duties in which they are exposed to subsurface soils through excavation work.

- **Future Site Trespasser:** Potential trespassers onto the site property. These exposures are evaluated under the assumption that current exposure controls, such as asphalt cover or gravel were removed.

3.2 Evaluation of Potential Exposure Pathways

An exposure pathway is a mechanism by which a receptor may come into contact with a constituent. An exposure pathway consists of the following four elements as defined in RAGS (USEPA, 1989a):

- A source and mechanism of constituent release
- A medium of transport for the constituent
- An exposure point at which the receptor may make contact with the constituent
- An exposure route through which constituent uptake by the receptor may occur

The evaluation of potential exposure pathways for completeness of the four elements is critical, since health risks do not exist in the absence of a complete exposure pathway. Complete pathways, which are determined to have the potential to adversely impact human health or environmental receptors, must be addressed when evaluating potential risks.

Figure 3 presents a Site Conceptual Exposure Model (SCEM) for the Former Coal Storage Yard. This figure is a visual depiction of potentially complete exposure pathways and the sources and mechanisms by which receptor populations might become exposed. As demonstrated in this figure, the original source of impacts at the Former Coal Storage Yard would have been spills or leaks of products handled at or near the facility. Once released, these constituents may have mixed/leached into surface soil and eventually into underlying subsurface soil and groundwater. Groundwater has the potential to migrate off-site to the Mississippi River (impacts to the river will be evaluated as part of the site-wide RFI). Exposure to contaminated media can occur when an individual comes into contact with the media. Because groundwater is not used at the site, and is located deeper than where construction activities would occur, there is little likelihood of any direct exposure to that medium, although there could be exposure to VOCs released from groundwater into air. Exposure to constituents in soils could occur via direct contact or indirectly via inhalation and incidental ingestion as VOCs are released into air.

The following is a summary of the results of the exposure pathway evaluation for each potential receptor population at the site:

- **Future Construction/Utility Worker:** Construction and utility workers may potentially be exposed to constituents in surface and subsurface soils at the site. Workers could be exposed to residual constituents in soil via incidental ingestion (i.e., hand-to-mouth activity).

  The dermal exposure pathway is not expected to present a significant exposure risk to the future construction/utility worker because tetrachloroethene is the only COPC present in subsurface soils at the site. Based on current USEPA guidance (USEPA, 2001b), volatile organic constituents are not evaluated for the dermal exposure pathway.

Although volatiles could be released into the air during trenching operations, exposure via inhalation is thought to represent a minor pathway because of the relatively low constituent concentration in soil and the high air exchange rate that would be associated with trenching in an open outdoor environment.

- **Future Outdoor Site Worker:** Future outdoor employees of the facility could be exposed to constituents in surface soil at the site via incidental ingestion of impacted soils.

  The dermal exposure pathway is not expected to present a significant exposure risk to the future outdoor site worker because tetrachloroethene is the only COPC present in subsurface soils at the site. Based on current USEPA guidance (USEPA, 2001b), volatile organic constituents are not evaluated for the dermal exposure pathway.

  Outdoor workers are also considered to have minor potential risk from the inhalation of residuals volatilized from groundwater and soil through a similar exposure pathway as the indoor site worker. This pathway is considered minor for the outdoor worker because of the low concentrations, low flux and large dilution of the constituent vapors as they reach the surface and disperse into the outside air.

- **Future Site Trespasser:** Trespassers onto the site property could potentially be exposed to surface soil constituents at the site via the same pathways as an outdoor site worker.

- **Future Indoor Site Worker:** Constituents in the groundwater, surface and subsurface soil could potentially volatilize and migrate to the surface where they could enter into buildings constructed above impacted media. Future workers in these buildings could be exposed to the volatilized constituents through inhalation.

3.3 Evaluation of Exposure Assumptions

In order to calculate the chronic daily intake (CDI) for exposure to constituents and to estimate the associated potential health risks, a number of exposure parameters must first be quantified. The exposure parameter values used in this risk assessment have been selected from the Exposure Factors Handbook (USEPA, 1997, 1989b), OSWER Directive 9285.6-03 (USEPA, 1991), RAGS (USEPA, 1989a), Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites Peer Review Draft (USEPA, 2001b) and through the use of professional judgement.

Exposure was evaluated for both RME and CTE exposure. The RME is an estimate of the maximum exposure that can reasonably be expected to occur. The CTE represents a more typical exposure for the average individual. The exposure parameters that have

been incorporated into the risk calculations for this report are listed in Table 3 and described in the following paragraphs.

3.3.1 Averaging Time

The assumed lifespan, used as the averaging time for evaluating carcinogens, as given in the OSWER Directive 9285.6-03 (USEPA, 1991), is 70 years (25,550 days) for all receptors.

The averaging time used for evaluating non-carcinogens was based on the duration and frequency of exposure. For exposure pathways with exposure durations of more than one year, the averaging time for non-carcinogens was calculated by multiplying the exposure duration times 365 days/year. For the future construction/utility worker pathway, which had an exposure duration of less than one year, the averaging time for non-carcinogens was an estimate of the total number of days that the construction activity would take to complete (including weekends and holidays). An estimate of 60 days was used for CTE and 240 days for RME.

3.3.2 Exposure Duration

Exposure duration refers to the number of years in which exposure occurs. On-site workers are assumed to have an RME duration of 25 years as given in OSWER Directive 9285.6-03 (USEPA 1991). A CTE exposure duration of 5 years was assumed, based on information supplied by the Bureau of Labor Statistics (U.S. Department of Labor, 1992) showing 5 years to be the average time an individual spends at one job.

For a trespasser, the exposure duration is assumed to be 30 years for RME and 9 years for CTE exposure based on the assumption that a trespasser could be a local resident.

Utility installation is considered the most likely future site-specific excavation activity. This type of activity generally occurs over a relatively short duration. Based on professional judgment, utility construction activity is assumed to be completed within one 8-month construction season.

3.3.3 Exposure Frequency

Exposure frequency refers to the total number of days per year spent at the site.

Current and future on-site workers are assumed to spend 250 days per year on-site for both RME and CTE exposure, based on a 5-day working week for 50 weeks per year (USEPA, 1991).

Hypothetical future utility/construction workers are assumed to have an exposure frequency of 30 days and 15 days per year for RME and CTE exposure, respectively, over a working period of 8 months and 2 months.

Because the site is partially fenced, and because there are no attractive features at the Former Coal Storage Yard that would be expected to encourage trespass, trespassers are assumed to visit the Site on an infrequent basis. It is assumed that the trespasser will visit the area 12 days per year for RME and 6 days per year for CTE exposure (e.g., twice a month for RME or once a month for CTE for the warmer 6 months of the year).

3.3.4 Incidental Soil Ingestion Rate

The incidental soil ingestion rate refers to the amount of soil that is ingested daily via incidental contact (e.g., hand-to-mouth contact). For RME exposure, Standard Default Exposure Factors (USEPA, 1991) recommends soil ingestion rates of 50 mg/day for worker populations. The incidental ingestion rate of 50 mg/day for industrial workers is also the value recommended by USEPA (1997) for all adults. This value is applied to the assessment of an on-site worker scenario. For calculations of CTE exposure, a value of 25 mg/day was used. These exposure estimations were also assumed to apply to a site trespasser.

Since soil excavation activity may involve increased exposure to soil, 200 mg/day was used as the RME soil ingestion rate for construction workers. This RME value is four times the RME value recommended by USEPA (1997) for evaluation of worker exposure, although less than the upper bound value of 330 mg/day identified in peer review draft USEPA guidance[1] (USEPA 2001b). For calculations of a construction worker's average exposure, a value of 100 mg/day was used.

3.3.5 Body Weight

The body weight for an adult was obtained from OSWER Directive 9285.6-03 (USEPA, 1991). The assumed body weight for adults is 70 kg. This value was used for on-site workers, construction/utility workers and trespassers.

3.3.6 Dermal Soil Absorption Factor

Dermal soil absorption values, used to estimate constituent absorption through the skin, were assumed to be 10 percent for semi-volatile organic compounds based on the draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 2001b). As specified in the draft guidance, inorganic and volatile organic compounds were not evaluated for dermal exposure.

3.3.7 Exposure Time

Exposure time refers to the number of hours per day in which the exposure occurs. A standard workday is eight hours long. The RME exposure time for the future construction/utility worker of 4 hours per day assumes that half of that time is spent

[1] Given the Peer Review Draft status of this guidance document, this value should be considered tentative.

actually working in the trench. A CTE exposure duration of 2 hours per day was assumed, also based on professional judgement.

3.3.8 Inhalation Rate

The inhalation rate was used to estimate the volume of trench air that the future construction/utility worker might breath while working in a hypothetical trench. Inhalation rates were taken from the Exposure Factors Handbook (USEPA, 1997). An inhalation rate of 2.05 m^3/hour, based on the assumption that half of the time spent working in a trench would involve moderate activity levels and half heavy activity levels, was used to evaluate the RME scenario. For the CTE scenario, a rate of 1.3 m^3/hour was used, based on the assumption that half of the time spent working in a trench would involve light activity levels and half moderate activity levels.

3.3.9 Skin Surface Area

Exposed skin surface area is important when evaluating uptake of constituents that are absorbed dermally. For dermal exposure to soil, an RME surface area of 3,300 cm^2 was estimated for potential adult receptor scenarios (hypothetical construction workers, utility workers, trespassers, and on-site workers) based on the adult surface areas of face, forearms, and hands (Exposure Factors Handbook; USEPA, 1997). For central tendency exposure, the total exposed surface area, assumed to be limited to the head and hands, was 2,000 cm^2 (USEPA, 1997).

3.3.10 Soil Adherence Factor

Dermal soil adherence is used, in conjunction with exposed skin surface area, to define the total amount of soil adhering to exposed skin surfaces. RME and CTE adherence rates used in this risk assessment are those requested by USEPA Region VII (USEPA, 2001c). For the construction/utility worker scenario, an adherence rate of 0.2 mg/cm^2 was used. For site workers, an adherence rate of 0.03 mg/cm^2 was used, based on the reported mean soil adherence of soil to hands, head and arms for groundskeepers.

For trespassers, RME and CTE adherence rates were taken from the Exposure Factors Handbook (USEPA, 1997). An adherence rate of 0.025 mg/cm^2 was used for both RME and CTE, based on the reported mean soil adherence of soil to hands, head and arms for soccer players.

3.4 Exposure Point Concentrations

Reasonable maximum exposure (RME) point concentrations were estimated as the lower of either the 95% UCL of the mean for the constituent concentration or the maximum detected concentration of the constituent. Central tendency exposure point concentrations (the average concentration of a constituent at the point of receptor contact) were estimated as the lower of either the RME concentration of the constituent or the arithmetic mean of the constituent concentration. A surrogate concentration of ½ of the

detection limit was used for non-detected samples in the calculation of the arithmetic mean and 95% UCL of the mean.

The 95% UCL was calculated based on guidance from USEPA (USEPA, 1992a). Since site related environmental impacts would be expected to be distributed lognormally, all data for the site were treated as lognormally distributed data sets. The assumption that the data is lognormally distributed results in a conservative estimation of the 95% UCL and thus a more conservative estimate of constituent exposure point concentrations. The analytical data for each constituent was first transformed by taking the natural logarithm of each result. The mean and standard deviation of the transformed data were calculated by standard statistical methods. The equation below was then used to calculate the 95% UCL for each constituent:

$$UCL = e^{(\bar{x}+0.5s^2+sH/\sqrt{n-1})}$$

Where:

UCL = upper confidence limit
e = base of the natural log (2.718)
x = mean of the log transformed data
s = standard deviation of the log transformed data
H = H statistic (obtained from statistics table)
n = number of samples

The 95% UCL was not calculated for data sets with only one detected concentration.

The most recent (Year 2000) groundwater data were included in the calculation of the exposure point concentrations for the Former Coal Storage Yard. Data from the uppermost aquifer layer were used in the calculation of the groundwater exposure point concentrations. In the event that duplicate samples were collected, the following methodology was used to select the result used for calculation of the exposure point concentration:

- If one result was qualified as detected and the other as not detected, the detected value was used
- If both results were qualified as detected, the original sample result was selected
- If both results were qualified as not detected, the result with the lower detection limit was selected

4.0 Toxicity Assessment

To estimate the potential non-carcinogenic hazards posed by the COPCs at the site, a hazard index (HI) approach was used. The concept of the hazard index is based on the assumption that non-carcinogenic toxicological effects of constituents occur only after a

threshold dose is achieved. The reference dose (RfD) for a compound is an estimate of the threshold dose below which the most sensitive human population will not experience an observed adverse effect for that compound. The hazard index is the ratio of the intake of a constituent to its specific reference dose. A hazard index in excess of one indicates that the threshold limit has been exceeded and a potential health hazard may exist. A hazard index of less than one indicates that adverse health effects are not expected to occur.

To estimate the potential risk from exposure to carcinogenic constituents of potential concern at the site, incremental carcinogenic risks were calculated. The incremental carcinogenic risk provides an estimate of the potential increase in cancer incidence for a receptor population. An incremental cancer risk of 1×10^{-6} corresponds to 1 chance in one million that an individual will acquire cancer due to exposure to site-related constituents. A risk range of 10^{-4} to 10^{-6} represents USEPA's opinion on what are generally acceptable levels (National Oil and Hazardous Substances Pollution Contingency Plan, March 1990, 40 CFR 300).

The hierarchy of sources of toxicity values used in the risk assessment is listed below:

- USEPA Integrated Risk Information System Database (IRIS) (USEPA, 2001a)
- Health Effects Assessment Summary Table (HEAST) (USEPA, 1997a)
- USEPA Region III Risk Based Concentration (RBC) Table (USEPA, 2000)

A summary of the Toxicity Values used in this Risk Assessment is presented in Table 4.

5.0 Risk Characterization

The purpose of risk characterization is to quantify the potential health risks associated with site-related impacts. In this portion of the Risk Assessment, potential health risks are estimated for each COPC and exposure pathway. These risk estimates are calculated using the exposure parameters developed in Section 3.0 and the toxicity values reported in Section 4.0.

5.1 Equations and Models Used to Calculate Risks and Hazards

5.1.1 General Risk Equations

Potential cancer risks and non-cancer hazard quotients have been calculated using the following equations:

Equation 1 (soil ingestion - cancer):

$$CR = \frac{C(S) * IRs * EF * ED * SF * CF}{BW * ATc}$$

Equation 2 (soil ingestion – non-cancer)

$$HQ = \frac{C(S) * IRs * EF * ED * CF}{BW * ATnc * RfD}$$

Where:

CR = Cancer risk (unitless)
C(S) = Constituent concentration in soil (mg/kg)
IRs = Soil ingestion rate (mg/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Conversion factor (kg/mg)
SF = Cancer slope factor $(mg/kg\text{-}day)^{-1}$
RfD = Non-cancer reference dose (mg/kg-day)
BW = Body weight (kg)
ATc = Averaging time for carcinogenic effects (days)
ATnc = Averaging time for non-carcinogenic effects (days)

5.1.2 Soil and Groundwater Constituent Volatilization into a Building

The hazard/risks associated with soil and groundwater constituent volatilization into a building were estimated using the Johnson-Ettinger model for constituent volatilization into a building (USEPA, 1997b). This is a spreadsheet application obtained from the USEPA. Tier 2 soil and Tier 2 groundwater models were run to allow for input of site specific parameters. Soil and groundwater calculations were run individually.

Table 5 presents the parameters used in the Johnson and Ettinger model. Standard default values were used in the spreadsheet unless otherwise noted. The building was modeled to have a slab concrete floor extending 15 cm into the ground. The depth of constituents used in the model was based on the detected depth range of the constituents and varied by constituent. In all cases, the finite source model was used. The soil was classified as a silty clay loam. The average soil temperature was set to 14°C, based on the climatic region of the site. The exposure duration and averaging time for non-carcinogens were changed from the default Johnson and Ettinger values to reflect those for the future indoor site worker as listed in Table 3.

Soil exposure point concentrations used as inputs to the model were based on the depth at which the constituent was detected. The maximum detected concentration of a constituent was used as the RME concentration in the model. The CTE concentration was estimated as the lower of the RME concentration or the arithmetic mean of the concentrations of the constituent. The mean concentration was determined only over the depths at which the constituent was detected.

5.1.3 Soil Constituent Volatilization into a Trench

A multi-step approach was used to estimate the risk to the future construction/utility worker from the inhalation of volatilized soil contaminants while working in a trench. The Exposure Model for Soil-Organic Fate and Transport (EMSOFT, USEPA, 1997c) was first used to calculate the average flux of volatilized constituents from impacted soils into trench air. A box model (USEPA, 1999) was then used to convert the constituent flux into an average trench air concentration. The predicted trench air constituent concentration was then used to calculate potential risks and hazards. Calculations were performed only for volatile COPCs. These are defined as COPCs with a MW of less than 200 and a Henry's Law constant of 1 x 10^{-5} atm-m3/mole or greater (USEPA, 1991b).

Parameters used in the EMSOFT modeling and Trench Box Model are presented in Table 6. Constituent properties for the EMSOFT model (e.g., diffusivity in air, Henry's law constant, etc.) were taken from the values in the Johnson and Ettinger Model spreadsheet. The non-carcinogenic averaging time for the exposure scenario was used as the time period for averaging constituent flux in the EMSOFT program. The constituent concentration was assumed to be evenly distributed throughout the entire area that the trench was cut through. The spatial locations of the impacted soil were not accounted for in this model.

The box model to convert constituent flux into a trench air concentration was based on a trench 30-m long and 3-m high. A trench width of 10-m at the opening with a 3 m floor was used in the calculations, based on Solutia excavation guidelines (see Appendix 4) for a trench of 3-m depth. The box model was modified to fit the trapezoidal shape of the trench. Constituent volatilization was only assumed to emanate from the 3-m wide floor of the trench. No volatilization was assumed from the angled sidewalls. An air exchange rate of 0.15 exchanges per second (based on a 10-mph wind speed) was used to account for air replenishment in the trench. A mixing factor of 0.5 was incorporated to account for incomplete mixing of air in the trench.

Exposure point concentrations for the soil contaminant volatilization into a trench pathway were taken from the subsurface soil (0-10 feet below ground surface) data. Reasonable maximum exposure point concentrations were estimated as the lower of either the 95% UCL of the mean for the constituent concentration or the maximum detected concentration of the constituent. Central tendency exposure point concentrations were estimated as the lower of either the RME concentration or the arithmetic mean of the constituent concentration. A surrogate concentration of ½ of the detection limit was used for non-detected samples in the calculation of the arithmetic mean and 95% UCL of the mean.

5.2 Results

Total non-carcinogenic hazard indices and carcinogenic risks associated with each receptor population and exposure route are presented in Table 7 and summarized below.

5.2.1 Future Construction/Utility Worker

The future construction/utility worker scenario was developed to evaluate potential exposures to subsurface soils. The total CTE non-carcinogenic hazard index was 0.00002 for the site. RME hazard indices ranged from 0.000008 to 0.000009. The total CTE cancer risk was 2×10^{-11}. RME cancer risks ranged from 2×10^{-11} to 5×10^{-11}.

5.2.2 Future Outdoor Site Worker

The future outdoor site worker scenario was developed to evaluate routine daily exposure to site surface soil by worker populations. Non-carcinogenic hazard indices were 0.000006 (CTE) and 0.00001 (RME) for the site. Total Cancer risks were 2×10^{-10} (CTE) and 2×10^{-9} (RME).

5.2.3 Future Site Trespasser

The future site trespasser scenario was developed to evaluate occasional exposure to site surface soils by non-worker populations. Non-carcinogenic hazard indices were 0.0000002 (CTE) and 0.0000006 (RME) for the site. Total Cancer risks were 1×10^{-11} (CTE) and 1×10^{-10} (RME).

5.2.4 Future Indoor Site Worker

The future indoor site worker scenario was developed to evaluate potential air emissions into a future building from soils and groundwater underlying the site. Non-carcinogenic hazard indices were 0.002 (CTE) and 0.003 (RME) for the site. The total CTE cancer risk was 3×10^{-7}. RME cancer risks ranged from 2×10^{-8} to 1×10^{-6}.

6.0 Conclusions

The risk evaluation performed for the Former Coal Storage Yard showed that risks and hazards to all identified current and future receptor populations at the site are within acceptable limits defined by USEPA and MDNR.

7.0 References

Hawley, J.K. 1985. Assessment of Health Risk From Exposure To Contaminated Soil. Risk Anal. 5:289-302.

U.S. Environmental Protection Agency (USEPA). 1989a. Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation, Part A. Interim Final. USEPA/540/1-89/002.

U.S. Environmental Protection Agency (USEPA). 1989b. Exposure Factors Handbook. May.

U.S. Environmental Protection Agency (USEPA). 1990. National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR 300.

U.S. Environmental Protection Agency (USEPA). 1991. Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.
U.S. Environmental Protection Agency (USEPA). 1992a. Supplemental Guidance to RAGS: Calculating the Concentration Term. OSWER Publication 9285.7-081.
U.S. Environmental Protection Agency (USEPA). 1992b. Dermal Exposure Assessment: Principles and Application. Washington, D.C.
U.S. Environmental Protection Agency (USEPA). 1997. Exposure Factors Handbook. August.
U.S. Environmental Protection Agency (USEPA). 1997a. Health Effects Assessment Summary Tables, FY-1997 Update.
U.S. Environmental Protection Agency (USEPA). 1997b. User' Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings. Office of Emergency and Remedial Response, Toxics Integration Branch. September.
U.S. Environmental Protection Agency (USEPA). 1998. Supplemental Guidance to RAGS: Region 4 Bulletins. Human Health Risk Assessment. Interim. January 16.
U.S. Environmental Protection Agency (USEPA). 1999. Derivation of a Volatilization Factor to Estimate Upper Bound Exposure Point Concentration for Workers in Trenches Flooded with Groundwater off-gassing Volatile Organic Chemicals. Memo from Helen Dawson to Tracy Eagle. July.
U.S. Environmental Protection Agency (USEPA). 2000. Region III Risk Based Concentration (RBC) Tables.
U.S. Environmental Protection Agency (USEPA). 2001a. IRIS (Integrated Risk Information System) Search.
U.S. Environmental Protection Agency (USEPA). 2001b. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Peer Review Draft. OSWER 9355.4-24. March.
U.S. Department of Energy (DOE) Office of Environmental Management (OEM). 2001. Risk Assessment Information System (RAIS).
U.S. Department of Labor (DOL). 1992. Employee Tenure and Occupational Mobility in Early 1990's. USDL 92-386.

T 1
Comparison of Soil Data to Screening Criteria
Former Coal Storage Yard
Solutia - Queeny

Chemical	Maximum	Minimum	Arithmetic Mean	Frequency	CALM value for Industrial Soil	Region III RBC for Industrial Soil	USEPA SSL - 20 DAF	CALM Leaching to Groundwater
SURFACE SOIL (0-2')								
Organics (mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
2-Butanone (MEK)	0.0086	0.0086	NA	1/3		1200000		
Acetone	0.04	0.018	0.39	2/3	8660	200000	16	14
Tetrachloroethene	0.26	0.26	NA	1/3	160	110	0.06	0.42
SUBSURFACE SOIL (0-10')								
Organics (mg/kg)								
2-Butanone (MEK)	0.0086	0.0086	NA	1/4		1200000		
Acetone	0.1	0.018	0.31	3/4	8660	200000	16	14
Chlorobenzene	0.017	0.017	NA	1/4	109	41000	1	2.2
Tetrachloroethene	0.26	0.26	NA	1/4	160	110	0.06	0.42
Xylene	0.073	0.073	NA	1/4	1510	4100000	29	55
ALL SOIL (0'-water table)								
Organics (mg/kg)								
2-Butanone (MEK)	0.0086	0.0086	NA	1/6		1200000		
Acetone	0.15	0.018	0.25	5/6	8660	200000	16	14
Chlorobenzene	0.017	0.014	0.03	3/6	109	41000	1	2.2
Ethylbenzene	0.0062	0.0062	NA	1/6	1460	200000	13	55
Tetrachloroethene	0.26	0.26	NA	1/6	160	110	0.06	0.42
Xylene	0.073	0.0072	0.05	2/6	1510	4100000	29	55

NOTE: Highlighting represents exceedence of a screening criterion. These chemicals were retained as contaminants of potential concern (COPCs).

Comparison of Groundwater Data to Screening Criteria and Selection of COPCs
Volatile Organic Compounds in the Uppermost Aquifer Layer
Coal Storage Area, Solutia - Queeny

ORGANICS (mg/L)	Maximum	Minimum	Arithmetic Mean	Frequency	MCL (when available) or Region 3 RBC (mg/L)
1,1,1-Trichloroethane	0.061	0.061	NA	1/1	0.200
Benzene	0.0068	0.0068	NA	1/1	0.005
Chlorobenzene	0.0035	0.0035	NA	1/1	0.1
Chloroform	0.0022	0.0022	NA	1/1	**0.00015**
Chloromethane	0.0036	0.0036	NA	1/1	**0.0021**
cis/trans-1,2-Dichloroethene	1.1	1.1	NA	1/1	0.07
Tetrachloroethene	0.0096	0.0096	NA	1/1	0.005
Trichloroethene	16	16	NA	1/1	0.005
Vinyl chloride	0.0011	0.0011	NA	1/1	0.002

NOTE: Region 3 RBCs are **BOLD**
Highlighting represents exceedence of a screening criterion. These chemicals were retained as COPCs.

Table 3
Exposure Parameters
Former Coal Storage Yard
Solutia-Queeny

	Future Construction/Utility Worker:		Current/Future Outdoor Site Worker:		Current/Future Site Trespasser:		Future Indoor Site Worker:	
	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Exposure Frequency (days/year)	15	30	250	250	6	12	250	250
Exposure Duration (years)	1	1	5	25	9	30	5	25
Incidental Soil Ingestion Rate (mg/day)	100	200	25	50	25	50	-	-
Body Weight (kg)	70	70	70	70	70	70	70	70
Averaging Time for Non-Carcinogens (days)	60	240	1,825	9,125	3,285	10,950	1,825	9,125
Averaging Time for Carcinogens (days)	25,550	25,550	25,550	25,550	25,550	25,550	25,550	25,550

Table 4
Toxicity Values for Constituents of Potential Concern
Former Coal Storage Yard
Solutia-Queeny

Chemical	Slope Factor: Oral $(mg/kg\text{-}day)^{-1}$	Slope Factor: Inhalation $(mg/kg\text{-}day)^{-1}$	Chronic Reference Dose: Oral (mg/kg-day)	Chronic Reference Dose: Inhalation (mg/kg-day)	Subchronic Oral Reference Dose (mg/kg-day)	Reference Concentration (mg/m^3)	Unit Risk Factor $(\mu g/m^3)^{-1}$
Benzene	NA	NA	NA	NA	NA	NTV	8.30E-06
Chloroform	NA	NA	NA	NA	NA	NTV	2.30E-05
Chloromethane	NA	NA	NA	NA	NA	9.00E-02	NTV
cis/trans-1,2-Dichloroethene[1]	NTV	NTV	9.00E-03	NTV	NTV	3.50E-02	NTV
Tetrachloroethene	5.20E-02	2.00E-03	1.00E-02	1.40E-01	1.00E-01	NTV	5.80E-07
Trichloroethene	1.10E-02	6.00E-03	6.00E-03	NTV	NTV	NTV	1.70E-06
Vinyl chloride	7.50E-01	1.50E-02	3.00E-03	2.80E-02	NTV	NTV	8.40E-05

NTV indicates that no toxicity value was found for that chemical of concern
NA indicates that the exposure pathway is not applicable to this risk evaluation

[1]Reference concentration is for cis-1,2-Dichloroethene

Table 5
Parameters Used for Johnson and Ettinger Air Modeling
Former Coal Storage Yard
Solutia-Queeny

Parameter	Units	Scenario: Soil Volatilization into a Building	Scenario: Groundwater Volatilization into a Building
Average Soil Temperature[1]	°C	14	14
Depth Below Grade to Bottom of Enclosed Space Floor	cm	15	15
Depth Below Grade to Water Table[2]	cm	-	750
Depth Below Grade to Top of Contamination[2]	cm	*	-
Depth Below Grade to Bottom of Contamination[2]	cm	*	-
Thickness of Soil Stratum A[2]	cm	*	750
Soil Stratum Directly Above Water Table[2]	-	-	A
SCS Soil Type Directly Above Water Table[2]	-	-	Silty Clay Loam (SICL)
Soil Stratum A SCS Soil Type[2]	-	Silty Clay Loam (SICL)	Silty Clay Loam (SICL)
Stratum A Soil Dry Bulk Density	g/cm^3	1.5	1.5
Stratum A Soil Total Porosity	unitless	0.43	0.43
Stratum A Soil Water-Filled Porosity	cm^3/cm^3	0.15	0.2
Stratum A Soil Organic Carbon Fraction	unitless	0.006	-
Enclosed Space Floor Thickness	cm	15	15
Soil-Building Pressure Differential	$g/cm\text{-}s^2$	40	40
Enclosed Space Floor Length	cm	961	961
Enclosed Space Floor Width	cm	961	961
Enclosed Space Height	cm	488	488
Floor-Wall Seam Crack Width	cm	0.1	0.1
Indoor Air Exchange Rate[3]	1/h	1	1

Shading of a value indicates use of a site-specific parameter

*Value was determined based on depth range of detected concentrations

[1]Average Soil Temperature is from USEPA Johnson and Ettinger Model User's Guide (EPA, 1997)

[2]Value determined from site analytical/geological data

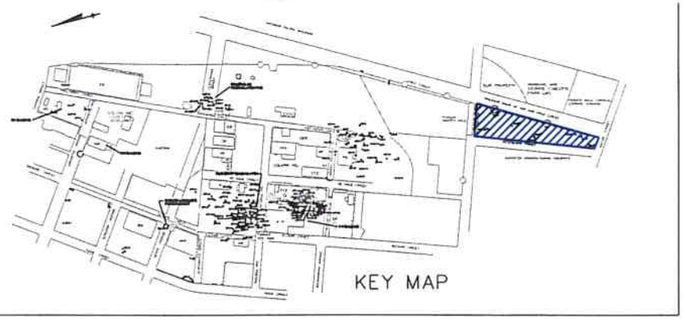
[3]Value based on St. Louis Building Code Air Exchange Information

Table 6
Parameters Used for EMSOFT Air Model for Soil Constituent Volatilization into a Trench
Former Coal Storage Yard
Solutia-Queeny

Constituent Parameters:	
Organic carbon partition coefficient (cm^3/g)	chemical specific
Henry's Law constant (Dimensionless)	chemical specific
Diffusion coefficient in Air (cm^2/day)	chemical specific
Diffusion Coefficient in Water (cm^2/day)	chemical specific
Number of Layers of contamination	1
Half life (days)	999,999
Soil parameters:	
fraction of organic carbon (unitless)	0.006
Porosity (unitless)	0.43
Water Porosity (unitless)	0.15
Bulk Density (g/cm^3)	1.5
Porewater Flux (cm/day)	0
Boundary Layer Thickness (cm)	1
Cover Thickness (cm)	1
Layer Thickness (cm)	305

Table 7
Summary of Potential Cancer Risks and Non-cancer Hazard Indices
Former Coal Storage Yard
Solutia-Queeny Site

	CTE		RME	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
		Future Construction/Utility Worker		
Ingestion	1.10E-11	0.000009	4.54E-11	0.000009
Inhalation	8.22E-12	0.00001	2.08E-11	0.000008
Total	2.E-11	0.00002		
		Future Outdoor Site Worker		
Ingestion	2.36E-10	0.000006	2.36E-09	0.00001
		Future Site Trespasser		
Ingestion	1.02E-11	0.0000002	1.36E-10	0.0000006
		Future Indoor Site Worker		
Inhalation of Soil COPCs	6.40E-09	-	1.60E-08	-
Inhalation of Groundwater COPCs	2.51E-07	0.002	1.20E-06	0.003
Total	3.E-07	0.002		



SLAY PROPERTY

HANDLING AND STORAGE CONCEPTS (FRITO LAY)

FORMER BULK CHEMICAL STORAGE TERMINAL

RAILROAD RIGHT OF WAY AND FIRST STREET

FORMER QUARRY AREA

BARTON STREET

VICTOR STREET

HW-3

HB-2GP

SB-I

HB-3GP

SB-H

HW-2GP

HW-2

SB-J

HW-1B

HW-1

KOSCUISKO STREET

SCHAEFER MANUFACTURING BUILDINGS

LEGEND:

- HW-26P SOIL BORING LOCATION
- SB-J RFI DATA GAP CONFIRMATORY SAMPLE
- HW-2 WELL SCREENED IN THE FILL & SILTY CLAY
- HW-1B WELL SCREENED IN SAND
- FENCE

NOTE:

SOIL ANALYTICAL SAMPLES OBTAINED FROM SOIL BORINGS AND/OR WELL LOCATION.

REFERENCE:
RCRA FACILITY INVESTIGATION DATA GAP WORK PLAN JOHN F. QUEENY PLANT BY O'BRIEN & GERE ENGINEERS, INC., SEPTEMBER 1999

0 100

SCALE FEET

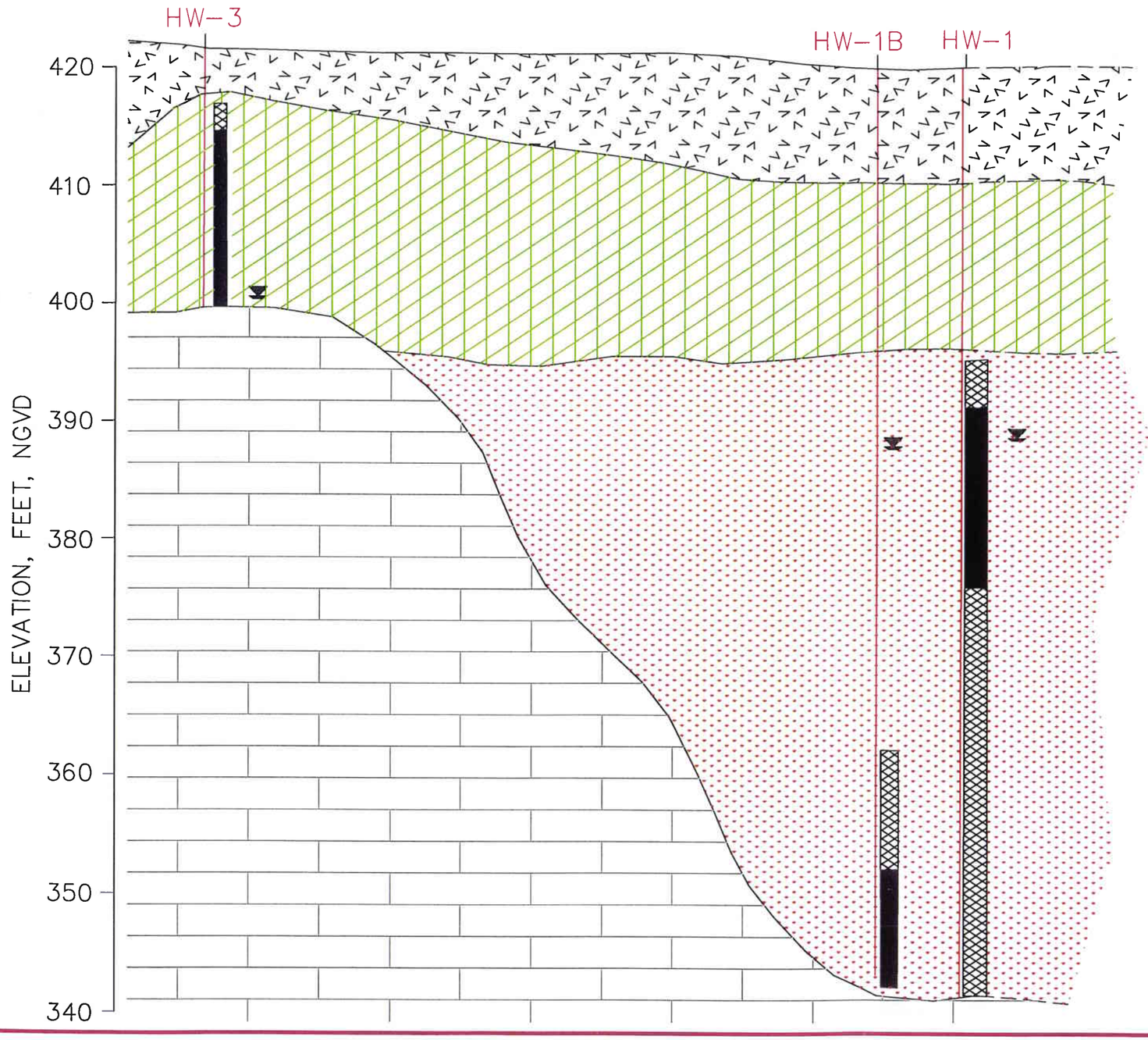
SOLUTIA INC. QUEENY PLANT ST. LOUIS, MISSOURI	PROJECT NO. 23.20000058.00
URS	
DRN. BY: CHS 11/02/00 DSGN. BY: TJA CHKD. BY:	FORMER COAL STORAGE YARD
	FIG. NO. 1

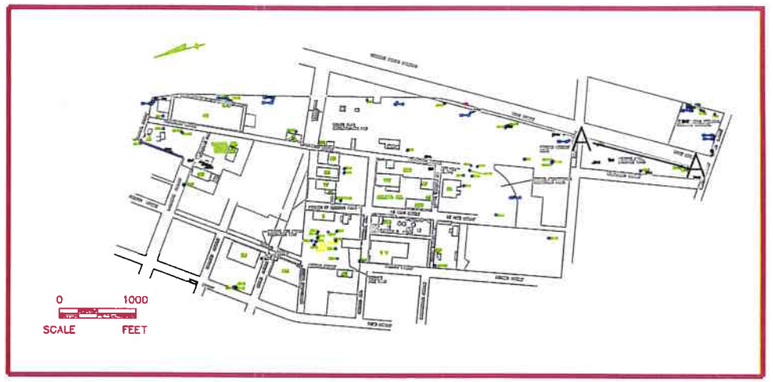
File: K:\ENVIRON\23-20000058.00 (SOLUTIA QUEENY)\CADD\RISK ASSESSMENT\050 (SOLUTIA)FORMER COAL STORAGE YARD.DWG Last edited: APR. 17, 01 @ 08:42 a.m. by: DJDEGUI0

REFERENCE:
RCRA FACILITY INVESTIGATION DATA GAP WORK PLAN JOHN F. QUEENY PLANT BY O'BRIEN & GERE ENGINEERS, INC., SEPTEMBER 1999

A (NORTH)

A' (SOUTH)





VERTICAL SCALE – 1"=10'
HORIZONTAL SCALE – 1"=100'

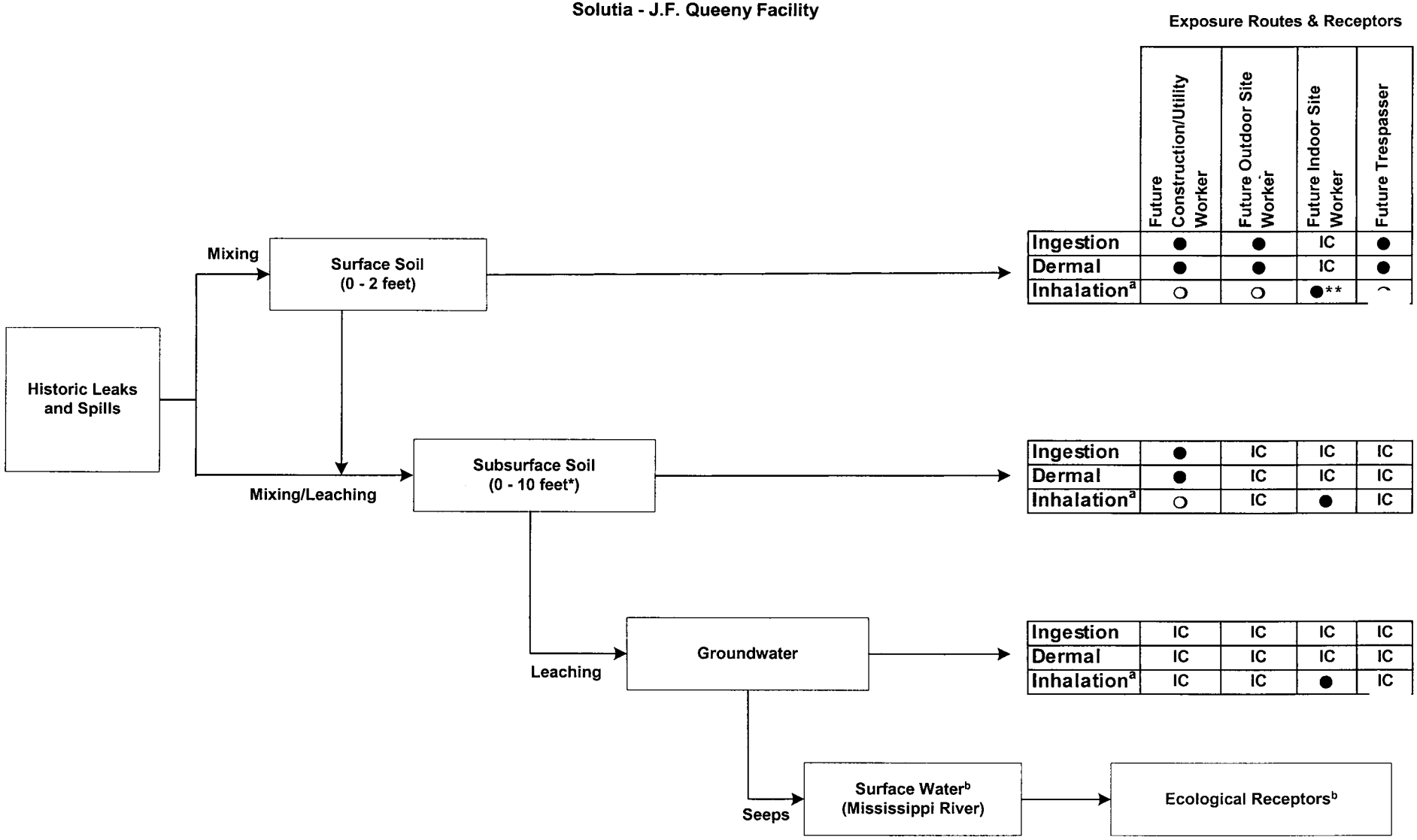
LEGEND

- FILL (CLAY, SILTS, GRAVEL, BRICK)
- CLAYS & SILTS
- SAND
- BEDROCK
- GROUNDWATER ELEVATION (AS MEASURED ON AUGUST 1 & 2, 2000)
- SCREENED INTERVAL
- FILTER PACK OR BACKFILL INTERVAL
- MW-30A MONITORING WELL IDENTIFICATION

SOLUTIA INC. QUEENY PLANT ST. LOUIS, MISSOURI	PROJECT NO. 2320000058.00
URS	
DRN. BY: djd 5/9/01 DSGN. BY: tja CHKD. BY:	Former Coal Storage Yard Subsurface Profile
	FIG. NO. 2

File: K:\ENV\...3-20000058.00 (SOLUTIA QUEENY)\CADD\2320000058.00(NEW-AGENCYMEETING)\CROSSSE...STRETCH.DWG Last edited: MAY 09, 01 @ 4:13 p.m. URS Corp.

Figure 3
Site Conc I Exposure Model
Forme I Storage Yard
Solutia - J.F. Queeny Facility



* For evaluation of indoor air, the surface soils, subsurface soils, and soils deeper than 10 feet were combined

** Evaluated as part of subsurface soils

IC Incomplete Pathway

● Complete and potentially significant

○ Complete but minor/insignificant

a Inhalation pathways refer to inhalation of volatilized compounds in a building (indoor site workers).

b There are no ecological receptors on-site. The Mississippi River is the only potential exposure point for ecological receptors. Groundwater impact to the river will be evaluated as part of the site-wide evaluation/RFI risk assessment.

October 22, 2001

Attachment 1
Former Coal Storage Yard
Solutia – Queeny

FORMER COAL STORAGE YARD

The ground covering in this area is crushed and compacted stone and coal fines. This property is currently used to temporarily store tractor-trailer parts; no buildings are located on the SWMU. The SWMU is located outside of the Queeny Plant main property and site security fence, but it is fenced along the eastern boundary and is partially fenced to the north, south, and west.

The photograph below depicts the former Coal Storage Yard, looking north.